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U. S. DEPARTMENT OF AGRICULTURE.

OFFICE OF EXPERIMENT STATIONS—BULLETIN NO. 162.

A. C. TRUE, Director.

## STUDIES

ON

# THE INFLUENCE OF COOKING UPON THE NUTRITIVE VALUE OF MEATS

AT THE

UNIVERSITY OF ILLINOIS,

1903-1904.

BY

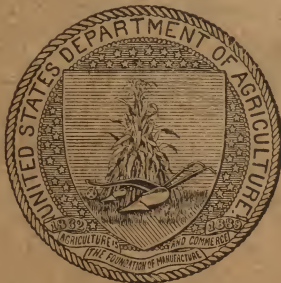
H. S. GRINDLEY, Sc. D.,

*Professor of General Chemistry, College of Science, University of Illinois,*

AND

A. D. EMMETT, A. M.,

*Research Chemist, Nutrition Investigations, University of Illinois.*



WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1905.





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## LETTER OF TRANSMITTAL.

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U. S. DEPARTMENT OF AGRICULTURE,  
OFFICE OF EXPERIMENT STATIONS,  
*Washington, D. C., December 20, 1905.*

SIR: I have the honor to transmit herewith a report of the investigations conducted in 1903-4 by H. S. Grindley, professor of general chemistry at the College of Science of the University of Illinois; and A. D. Emmett, research chemist in the nutrition investigations of the same institution, in accordance with instructions from this Office. As in earlier work, Professor Grindley's object has been to secure accurate information regarding the losses sustained when meat is cooked in different ways, and the effects of cooking upon flavor, palatability, and nutritive value.

In the course of the investigations, material aid has been rendered by Prof. Herbert W. Mumford, of the department of animal husbandry of the Illinois Agricultural Experiment Station, and by Prof. Isabel Bevier, of the department of household science, of the University of Illinois. Acknowledgment should be made of the valuable assistance rendered by Miss E. C. Sprague, and Messrs. F. W. Gill, S. J. McGrath, and J. M. Barnhart.

In the present bulletin, which is considered a progress report, the details of fifty-one experiments are reported, in which studies were made of the nutritive value of different kinds and cuts of meat cooked in various ways.

The investigations reported furnish data of practical as well as scientific interest, and it is recommended that the report be published as Bulletin No. 162 of this Office.

Respectfully,

A. C. TRUE,  
*Director.*

Hon. JAMES WILSON,  
*Secretary of Agriculture.*



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# INFLUENCE OF COOKING UPON THE NUTRITIVE VALUE OF MEATS.

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## INTRODUCTION.

In the United States there is a greater production of meat than in any other country in the world, our animal products being second only in importance to our cereal products. The reports of the census for 1900 show that the meats and meat products slaughtered and prepared that year by the wholesale packing houses of this country were worth at wholesale prices \$779,000,000. It must be remembered that this does not include the value of the meat and meat products which pass directly through the hands of the butchers and other retailers, nor that of animals which the farmers and other consumers slaughter for their own use, so the total value of the meat and meat products would be considerably larger than the figure quoted.

A detailed study of the results of 267 dietary studies which have been made in America shows an average expenditure of 7.2 cents per man per day for meats. The cost of meat forms 37.2 per cent of the total cost of the food, and the meat furnishes 38.6 per cent of the protein, 58.9 per cent of the fat, and 18.5 per cent of the total nutrients of the diet. Furthermore, available statistics show that we also consume more of this food than any other nation, the inhabitants of the United States annually using on an average about 120 pounds of meat per capita.

Since it is evident that meats play such an important rôle in commercial and domestic economy, it seems obvious that there is abundant reason to justify any study, however extended, which will increase our knowledge of the nutritive and economic value of meats and their products.

Investigations made from 1898 to 1903 at the University of Illinois under the auspices of this Office in cooperation with the university, upon the nature and the extent of the losses which meat undergoes during the process of cooking, have already been published.<sup>a</sup> In connection with those investigations a large number of experiments were made which had for their object the determination of the influence of

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<sup>a</sup> U. S. Dept. Agr., Office of Experiment Stations Buls. 102 and 141.

the cooking of meats upon their total digestibility, and upon the ease and rapidity of their digestion, and the results obtained, which have been described in part,<sup>a</sup> it is expected will soon appear in full as a bulletin from this Office.

During the year 1903-4 the methods used in these studies have been in a number of ways materially extended in scope and modified in form. The plan of the investigations has also been extended with a view to studying as completely as possible the influence of different methods of cooking upon the nutritive value of meats and the character of the physical and chemical changes which take place in meats when they are cooked by various common methods. It is the object of this bulletin to describe this work and to give in detail some of the results which have so far been obtained.

The work here reported includes (1) thirty-one experiments made to determine the amount of the losses which result in the cooking of meats in hot water at different temperatures and for different lengths of time, a special feature being a detailed study of the nature of the nutritive constituents of the meats before and after cooking; (2) four experiments to estimate the amount and character of the losses which take place when meats are cooked by pan broiling and at the same time to find out the relation existing between the nutritive value of the raw and that of the cooked meats; (3) three experiments to find what losses and changes in nutritive value result when meats are cooked by roasting; (4) six experiments to determine the losses and also the changes in nutritive value which meats undergo when they are cooked by sautéing, frying, gas broiling, and pot roasting; (5) three experiments to show the influence of the different methods of cooking meats upon flavor and palatability, and (6) four experiments to determine the amount and nature of the substances which bones yield when cooked in hot water, as in making soup.

### HISTORICAL REVIEW.

A review of chemical literature shows that many studies of the changes brought about in various proteids, fats, and carbohydrates by oxidation by heat or otherwise, and by treatment with water under pressure or other methods of hydration and by the action of different reagents have been undertaken which, properly considered, would throw light on the changes brought about by cooking. But apparently no attempt has as yet been made to collect and digest this widely scattered material. An extended search of the literature of the subject indicates that comparatively few experimental investigations have been undertaken with the direct object of studying the chemical, histological, and other changes which different foods undergo during the process of cooking. Considerable has been said by different writers

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<sup>a</sup> Univ. Ill., Univ. Studies, vol. 1, No. 5, p. 1.

regarding the effects of cooking upon nutritive value, and more especially upon chemical composition and digestibility, but as a rule the statements are not accompanied by experimental data nor do the generalizations always show evidence of being based upon careful laboratory investigations.

Many studies have been made with a view to ascertaining the chemical structure of different proteid bodies of animal and vegetable origin, and at the present time many investigators are working along these lines. The majority of the proteids studied, it seems fair to say, are not those occurring in meats used as food, and the statement seems warranted that up to the present time little is definitely known regarding the chemistry of uncooked meats, and still less regarding the complex changes brought about by different methods of cooking. Whatever is known, however, is of great interest and value, not only for itself but for the suggestions it offers for future lines of work.

In 1895 Atwater<sup>a</sup> compiled and studied the results of investigations on the changes brought about when meat and other foods are cooked. The experimental data regarding the effects of cooking on the composition, digestibility, and nutritive value of foods were discussed, as well as data regarding the losses resulting during the cooking of meats, and also regarding the composition and nutritive value of broth.

In König's<sup>b</sup> extended compilation of data relative to the chemistry of foods and food products, investigations are summarized which have to do with the cooking of food. That the amount of such data was limited is shown by the fact that the summary covers only 16 pages.

The results of a number of studies, most of them carried on by American and English investigators, which add to our knowledge of the changes which take place when foods are cooked, have been published but are not included in either of the compilations just cited.

The changes which take place in the carbohydrates when sweet potatoes are baked was studied by W. E. Stone.<sup>c</sup>

Snyder, Frisby, and Bryant<sup>d</sup> have reported determinations of the losses of nutrients resulting in the boiling of potatoes, carrots, and cabbage. Katherine I. Williams<sup>e</sup> has studied in detail the chemical composition of cooked vegetables as served at the table. Voorhees,<sup>f</sup> Isabel Bevier,<sup>g</sup> Snyder,<sup>h</sup> and Woods<sup>i</sup> have published results of investigations showing the losses involved in the process of bread making.

<sup>a</sup> U. S. Dept. Agr., Office of Experiment Stations Bul. 21, p. 91.

<sup>b</sup> *Chemie der Menschlichen Nahrungs- und Genussmittel*. 4. ed., vol. 2, p. 1244.

<sup>c</sup> *Ber. Deut. Chem. Gesell.*, 23 (1890), p. 1406; *Agr. Sci.*, 14 (1890), p. 31.

<sup>d</sup> U. S. Dept. Agr., Office of Experiment Stations Bul. 43.

<sup>e</sup> *Jour. Amer. Chem. Soc.*, 26 (1904), p. 244.

<sup>f</sup> U. S. Dept. Agr., Office of Experiment Stations Buls. 35 and 67.

<sup>g</sup> U. S. Dept. Agr., Office of Experiment Stations Bul. 52.

<sup>h</sup> U. S. Dept. Agr., Office of Experiment Stations Buls. 67, 101, and 126.

<sup>i</sup> U. S. Dept. Agr., Office of Experiment Stations Bul. 85.

The chemistry of cooked meats, and the losses and chemical and physical changes involved in the cooking of meats have also received some attention in recent years. Schwenkenbecher<sup>a</sup> has made a special study of the composition of cooked foods, both animal and vegetable. Katherine I. Williams<sup>b</sup> has analyzed a considerable number of samples of cooked fish of different kinds. Allen<sup>c</sup> reported the results of the analysis of a number of different kinds of cooked meats which were made in his laboratory by A. R. Tankard. Atwater,<sup>d</sup> Grindley,<sup>e</sup> Thudicum,<sup>f</sup> and Grindley and Mojonnier<sup>g</sup> have made and reported investigations which show the nature and extent of the losses which meats undergo during cooking by the methods in common use. Offer and Rosenquist<sup>h</sup> have studied the nature of the nitrogenous principles of poultry, fish, and different kinds of raw, cooked, and preserved meats and in raw and fried veal. Isabel Bevier and Elizabeth C. Sprague<sup>i</sup> have reported investigations regarding the influence of pans of different kinds and shapes, of time of cooking, of temperature, and of different shapes and size of cuts, upon the losses which occur in the roasting of beef. Grindley and Mojonnier<sup>j</sup> have studied the influence of the cooking of meats upon their total digestibility and upon their ease and rapidity of digestion.

M. Rubner,<sup>k</sup> in a recent publication, gives in brief a résumé of researches which have been made in his laboratory upon the chemistry, the cooking, and the nutritive value of meats. The results which were obtained will be referred to in detail in connection with the discussion of several of the topics considered in this bulletin.

The investigations carried on in Illinois in the past have been so largely devoted to the determination of the losses involved in the cooking of meats that they have in the main only indirectly thrown new light upon the character and nature of the physical and chemical changes which meats undergo during cooking, and they have therefore given us only a little additional information regarding the nutritive value of cooked meats. The investigations reported in this bulletin were undertaken for the purposes of studying as thoroughly as possible the changes in nutritive value which meats undergo during the process of cooking.

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<sup>a</sup>Inaug. Diss., Marburg, 1900.

<sup>b</sup>Jour. Chem. Soc. [London], 71 (1897), p. 649.

<sup>c</sup>Commercial Organic Analysis, Philadelphia, 1898, vol. 4, p. 275.

<sup>d</sup>N. Y. State Com. Lunacy, Ann. Rpt., 11 (1900).

<sup>e</sup>U. S. Dept. Agr., Office of Experiment Stations Bul. 102.

<sup>f</sup>The Spirit of Cookery, London, 1895.

<sup>g</sup>U. S. Dept. Agr., Office of Experiment Stations Bul. 141.

<sup>h</sup>Berlin. Klin. Wehnschr., 36 (1899), pp. 937, 968, and 1086.

<sup>i</sup>Illinois Station Circ. 72.

<sup>j</sup>Univ. Ill., Univ. Studies, vol. 1, No. 5, p. 1.

<sup>k</sup>E. von Leyden. Handbuch der Ernährungstherapie. Leipsic, 1903, 2. ed., p. 84.



## ANALYTICAL METHODS.

In order to investigate the nature of the physical and chemical changes which occur in the cooking of meats, the ordinary methods for the proximate analysis of foods are not sufficient. Thus, when meat is boiled, the mere determination of the water, protein, fat, and ash in the broth and also in the meat before and after cooking does not give a sufficient amount of information regarding the proximate principles which they contain. Further, there are serious objections to the customary preliminary preparation of air-dried samples, because this procedure produces fundamental changes in the proteid constituents and undoubtedly affects to some extent the nature of the fats and probably also that of the organic extractives. The changes which air drying brings about in the proteids prevent subsequent separation and examination of these substances, since they are for the most part, if not entirely, rendered insoluble by this treatment. Since the investigations here reported seemed to necessitate a study of the water extracts of raw and cooked meats in order to distinguish more completely between their proximate constituents, it seemed desirable to analyze the fresh substance of the meats without first preparing an air-dried sample according to the usual practice.

In former investigations<sup>a</sup> carried out in this laboratory an effort was made to adapt the ordinary methods to the analysis of the fresh substance of both raw and cooked meats without preliminary air drying. At that time the results obtained were not as satisfactory as were desired. Further work has been done, and it is believed that the various modifications here introduced in the details of the ordinary method have produced more accurate results.

In general, the method used follows the outline of procedure recommended by the Association of Official Agricultural Chemists,<sup>b</sup> with such modifications as were described in a former bulletin of this Office,<sup>c</sup> together with further changes of details which have been found necessary when the fresh substance of meats is used instead of the air-dried material. Only these last changes need be described here. Much care was taken in preparing and thoroughly mixing the samples for analysis. In every case the weighings were made by difference, a glass-stoppered weighing bottle being used. For the determination of water the samples were weighed in glass tubes with filter-paper bottoms, such as are ordinarily used in ether extraction of fat by the Johnson method.<sup>d</sup> In cases where the meat was rather fat, filter blocks made of fat-free paper were first put into the tubes, the tubes and their

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<sup>a</sup> U. S. Dept. Agr., Office of Experiment Stations Bul. 102.

<sup>b</sup> U. S. Dept. Agr., Division of Chemistry Bul. 46, revised.

<sup>c</sup> U. S. Dept. Agr., Office of Experiment Stations Bul. 141.

<sup>d</sup> Amer. Jour. Sci., 13 (1877), p. 190.

contents were dried at first very slowly in a water oven at a low temperature, and the determination then continued as usual.

The fat was determined by extracting with anhydrous ether the dried samples remaining after the estimation of water. After twenty-four hours' extraction the samples were removed and intimately ground with ignited sand, then transferred again to the moisture tubes, which were loosely plugged with fat-free cotton to prevent any of the material from being mechanically carried into the flasks, and the extraction continued for twelve hours. The usual Kjeldahl method was used for the determination of the total nitrogen, special care being taken in transferring the weighed meat to the Kjeldahl flask that none of the material should adhere to the neck. In the distillation it was found that pumice stone was preferable to granulated zinc, as experiments made in this laboratory show that zinc reduces some forms of nitrogen compounds which are always present in the ordinary alkali, and thus introduces a slight error. The ash was determined as usual, but much care was taken to heat the muffle very slowly and gradually at first so as to prevent loss by sputtering.

A careful and thorough test of this method for the direct determination of water, fat, nitrogen, and ash in the fresh substance of meats has demonstrated its accuracy, and it may be considered of unquestionable advantage in these investigations or others of similar nature.

#### **PREPARATION AND ANALYSIS OF COLD-WATER EXTRACTS OF MEATS.**

As has already been said, in order to learn very much regarding the chemistry of the cooking of meats it is necessary to distinguish much more completely between their proximate principles than is done by the ordinary methods of analysis. It was believed that in the meat investigations here reported, as well as in future work, this could be best accomplished by studying the cold-water extracts of meats. After much preliminary experimenting (which it is not necessary to describe in this connection), a method of preparation and analysis of the cold-water extracts of meats was elaborated and adopted. Since, so far as the authors are aware, no method has been as yet proposed or described for so complete an analysis of meats and other foods, the method used is described here in detail.

The uncooked or cooked meat was cut into small pieces and then passed three times through a small sausage mill or meat cutter. After each grinding, the mill was cleaned and the meat thoroughly mixed. Three portions, of 30 to 33 grams each, were then weighed, the meat being thoroughly mixed each time before any of it was removed. Each lot of 30 to 33 grams was distributed as equally as possible between six small beakers. The samples were moistened with a little

distilled water and all lumps broken up with a glass rod. Fifty cubic centimeters of water was then added to each beaker and the contents stirred thoroughly for fifteen minutes. After the insoluble residue had been allowed to settle for three to five minutes, the liquid from each beaker was decanted through filters into 250 cubic centimeter flasks. The insoluble portion was thoroughly drained and then 25 cubic centimeters of water was added. The water and residue were thoroughly stirred for seven to eight minutes, and, after settling, decanted upon the same filter as before. This treatment was continued, 25 cubic centimeters of water being used each time, until the filtrate from each portion of meat measured about 230 cubic centimeters. The material on the filters was allowed to drain completely after each extraction. After the last extraction the entire content of each beaker was thrown upon the filter and, when drained, was washed twice with a small quantity of distilled water. Each flask was rinsed twice with water, after which the filtrates were combined and diluted to 5 liters.

*Determination of total solids and ash.*—Portions of the filtrate of 100 cubic centimeters each were evaporated to dryness in weighed platinum dishes. The residues were dried in a water oven for one hour or until the weight of each was approximately constant. The dried residues were ignited carefully over a free flame at a very low red heat until colorless or nearly so. The ash was weighed quickly, reheated, and again weighed. This treatment was repeated until the weight was constant.

*Determination of total nitrogen.*—Portions of 100 cubic centimeters each were used to determine the nitrogen by the usual Kjeldahl method. Dilute standard solutions (about one-fifteenth normal) were used for this part of the work.

*Determination of nitrogen precipitated in the form of coagulated proteids in neutral solution.*—Portions measuring 200 cubic centimeters were evaporated upon the water bath to a volume of about 40 cubic centimeters. The solution was then exactly neutralized with decinormal sodium hydroxid solution, litmus paper being used as indicator. The neutral solutions were warmed upon the water bath for ten minutes, then filtered at once, and the coagulated residues washed thoroughly with hot water. The nitrogen in the residues was determined, much care being taken to remove all the coagulated proteid from the beakers.

*Determination of nitrogen precipitated as albumoses by zinc sulphate.*—The filtrates and washings from the above determinations of coagulable proteid were evaporated upon the water bath to a volume of 30 cubic centimeters and allowed to cool. One cubic centimeter of 50 per cent sulphuric acid was added and the solution completely saturated with crystallized zinc sulphate. The solution was heated upon a water bath with constant stirring until perfectly clear, allowed to stand

twelve hours and then filtered, after which the precipitate was thoroughly washed with a saturated solution of zinc sulphate, slightly acidified with sulphuric acid. The nitrogen in the precipitate was then determined.

*Determination of nitrogen precipitated by tannin and sodium chlorid.*—Measured portions of 200 cubic centimeters each of the cold-water extract were transferred to 250 cubic centimeter measuring flasks and 1 gram of pure sodium chlorid and 5 cubic centimeters of a solution containing 12 per cent of tannin were added. The solution was then diluted to 250 cubic centimeters, allowed to stand twelve hours, filtered through a dry filter, and the nitrogen determined in a measured volume (200 cubic centimeters) of the filtrate.

*Determination of nitrogen precipitated by phosphotungstic acid from a cold solution.*—Measured amounts of 200 cubic centimeters each of the cold-water extract were transferred to 250 cubic centimeter measuring flasks, with 5 cubic centimeters of 50 per cent sulphuric acid and 10 cubic centimeters of phosphotungstic acid solution (prepared as directed by Wiley).<sup>a</sup> The solution was then diluted to 250 cubic centimeters, allowed to stand twelve hours, filtered through a dry filter, and the nitrogen determined in 200 cubic centimeters of the filtrate.

*Determination of nitrogen precipitated by phosphotungstic acid from a hot solution.*—Measured portions of 200 cubic centimeters each of the cold-water extract were treated with 5 cubic centimeters of 50 per cent sulphuric acid and then heated to rapid boiling. A slight excess (10 to 15 cubic centimeters) of phosphotungstic acid solution was added and after boiling gently for five minutes the hot solution was filtered. The precipitate was washed thoroughly with boiling water and then the nitrogen which it contained was determined.

*Determination of nitrogen precipitated by Stutzer's reagent.*—Measured amounts of 200 cubic centimeters of the cold-water extract each were placed in 250 cubic centimeter measuring flasks and 3 cubic centimeters of Stutzer's reagent was added. The solution was then diluted to 250 cubic centimeters, thoroughly mixed, allowed to stand twelve hours, filtered through a dry filter, and the nitrogen determined in measured portions (200 cubic centimeters) of the filtrate.

*Determination of nitrogen as ammonia.*—Portions of 200 cubic centimeters each of the cold-water extract were distilled with magnesium oxid in the form of milk of magnesia and the ammonia thus liberated was determined in the usual way.

*Determination of nitrogen compounds precipitated directly by bromin.*<sup>b</sup>—Portions of 200 cubic centimeters each of the cold-water extract were transferred to Kjeldahl digestion flasks, acidified with 2

<sup>a</sup> Principles of Agricultural Analysis, vol. 3, p. 454.

<sup>b</sup> This determination has recently been discontinued, as bromin has been proved to be an unreliable precipitant for proteids.



cubic centimeters of normal hydrochloric acid, and then treated with a slight excess of bromin while being vigorously shaken. The mixture was allowed to stand twenty-four hours, then filtered, and the precipitate washed thoroughly with water saturated with bromin. The nitrogen was then determined in the precipitated proteid.

*Determination of nitrogen precipitated by bromin in the filtrate from the zinc sulphate precipitate.*<sup>a</sup>—The zinc sulphate filtrate was diluted with an equal volume of water and 2 cubic centimeters of normal hydrochloric acid was added. The precipitation with bromin was continued as in the determination described above.

#### METHODS OF ANALYZING THE BROTHS.

The methods used in analyzing the broths in the experiments here reported are fundamentally the same as those described in previous bulletins of this Office.<sup>b</sup> Nevertheless, as they differ in some of the details, a brief outline of them is here given. Upon removing the cooked meat from the vessel in which it was boiled, the hot broth was immediately filtered through a sieve with circular openings of 1 millimeter. The residue in the sieve, consisting chiefly of fragments of meat, was added to the cooked meat. The broth was rapidly cooled to about 15° C. and strained through a piece of cheese cloth previously washed with water, alcohol, and ether. By this means most of the suspended coagulated albumin and nearly all of the solidified fat were separated. This coarse residue, after being washed with cold water, was dried and analyzed, first the fat and then the nitrogen being determined. The filtered broth was diluted with water to a definite volume and after thorough mixing six portions of 250 cubic centimeters each were filtered through ash-free filters. In this manner a clear broth was obtained. The solid material collected upon the filters was designated as "fine residues," and the ash, nitrogen, and fat in these residues were determined in duplicate. The total solid matter, ash, proteid nitrogen, nonproteid nitrogen, and extractives in the clear filtered broths were determined by the methods described above for the analysis of the cold-water extracts of meats, and in addition, in order to get if possible a further insight into the nature of the nitrogenous constituents present in broths and to study and compare methods for determining these bodies, the following determinations were made: Nitrogenous compounds precipitated by bromin directly; nitrogenous constituents precipitated by tannin and sodium chlorid; compounds of nitrogen precipitated by phosphotungstic acid in the cold; nitrogenous substances precipitated by phosphotungstic acid in

<sup>a</sup> This determination has recently been discontinued, as bromin has been proved to be an unreliable precipitant for peptones.

<sup>b</sup> U. S. Dept. Agr., Office of Experiment Stations Buls. 102 and 141.

boiling solutions; nitrogenous bodies precipitated by Stutzer's reagent, and nitrogen as ammonia or its compounds. The methods used in making these determinations in broths were similar to those described above for their determination in the cold-water extracts.

### OBJECT AND PLAN OF THE COOKING EXPERIMENTS.

The object of the experiments here reported, expressed briefly and concisely, was to study: (1) the losses resulting from different processes of cooking; (2) the influence of cooking on the composition and nutritive value of meats; (3) the nature of the changes in composition resulting when meat is cooked by different methods; and (4) the nature of the water extracts of raw and cooked meats.

In planning the work it was naturally found that the results of one experiment might help toward the solution of several of these problems, and the question of their classification was thereby rendered complex. For instance, the main purpose of Series VIII was to test the differences between the changes occurring in different cuts of meat all cooked by the same method, and in the first three experiments (Nos. 121-123) three different cuts of beef were boiled in exactly similar ways. But in the fourth experiment (No. 124) the purpose was to study the differences produced by different methods of cooking on the same cut, and a piece of meat like that boiled in experiment No. 123 was pan broiled. Thus experiment No. 123 really belongs to two separate series, but for convenience both are included in one series. The classification finally adopted is based on the kind of meat and the method of cooking rather than upon chronological sequence. If the results of any individual experiment can advantageously be used in connection with another series, reference can be made to it by number, as will be done in later sections of this bulletin.

Although the method of cooking is not the most important feature of all these experiments, it is nevertheless one from which many significant deductions can be drawn. Boiling, pan broiling, roasting, sautéing, frying, gas broiling, and pot roasting were the methods employed. They were essentially the same as those described in a previous bulletin of this Office,<sup>a</sup> any minor variations being given with the individual experiments. In experiments Nos. 119, 124, 142, and 151 the samples were pan broiled; in Nos. 120, 147, and 156 they were roasted; in Nos. 141 and 150, sautéed; in No. 143, fried; in No. 152, gas broiled; and in Nos. 146 and 155, pot roasted. In the remaining experiments (Nos. 107-118, 121-123, 125, 126, 131-140, 144, 145, 153, and 154) the meats were cooked by boiling, and a detailed description of this method is here given, partly to explain the somewhat

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<sup>a</sup>U. S. Dept. Agr., Office of Experiment Stations Bul. No. 141.

complicated processes by which the complete results were obtained and partly because of the special importance of the broths so produced.

There is considerable variation in the way in which the terms "boiling," "stewing," and "simmering" are used. In the present investigation, as was the case in earlier work, the term "boiling" has been used to cover cooking in hot water at any temperature; however, in every case the temperature of the water during cooking has been recorded, so it will not be difficult, should it at any time be desirable, to decide whether the meat was cooked by stewing, simmering, or true boiling.

The steps which were taken in developing the experimental methods for determining the losses of nutrients and the chemical and nutritive changes which result in the cooking of meats by boiling have been given in full in previous publications from this Office.<sup>a</sup> It is, however, necessary to say in this connection that in cooking meat in hot or in boiling water it was found that there was no appreciable loss of nutritive material by volatilization, but that practically all the nutrients removed from meat by this method of cooking passed into the resulting broth. In reporting the results of these investigations all material separated from the meat during the cooking, whether mechanically or by solution, has therefore been designated "loss" by cooking. The material thus removed, however, is not necessarily an actual loss from the standpoint of household economy if the broth is used as soup or is otherwise consumed as food.

In each cooking experiment one sample of meat was reserved uncooked for direct analysis. The portions cooked were weighed before and after cooking, and the difference in each case was taken as representing the total loss in weight resulting from the process of cooking. The material lost consisted partly of water and partly of nutritive ingredients contained in the broth. The broth was analyzed by the methods given above (see pages 15, 16), the proteid, fat, ash, and organic extractives, both nitrogenous and nonnitrogenous, being determined. The total loss in weight minus the weight of these ingredients in the broth was assumed to represent the quantity of water removed from the meat in cooking. The cooked meat was then analyzed and the amount of each nutrient in it was added to that in the broth and the sum taken as the amount of the nutrients in the raw meat. This was found in every case to correspond so closely to the figures obtained by the direct analysis of the uncooked samples that it seemed fair to include the results of the two methods in one table, as has been done in the report of the experiments. From these amounts and the amounts in the broth the percentage loss of each ingredient was calculated.

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<sup>a</sup> U. S. Dept. Agr., Office of Experiment Stations Buls. 102 and 141.

The calculation and interpretation of the results of the experiments may be illustrated by the following examples: In experiment No. 108 (p. 22) the weight of the meat before cooking was 1,000 grams and the weight of the cooked meat 534.54 grams. The total loss in weight was therefore 465.46 grams, which is equivalent to a loss of 46.55 per cent of the weight of the original meat.

The chemical composition of the edible portion of the meat before and after cooking and also of the resulting broth is shown in Table 3 (p. 23). The composition of the uncooked beef round was found by direct analysis to be: Water 74.04 per cent, proteid 19.63 per cent, nitrogenous extractives 1.37 per cent, nonnitrogenous extractives 1.72 per cent, fat 3.19 per cent, and ash 1.18 per cent. The same table shows that the composition of the cooked beef round from another similar sample analyzed after cooking was: Water 59.01 per cent, proteid 36.27 per cent, nitrogenous extractives 0.33 per cent, nonnitrogenous extractives 0.45 per cent, fat 4.38 per cent, and ash 0.50 per cent. The percentage composition of the complete broth reckoned on the basis of the total weight of uncooked meat from which it was made as shown by this same table is, proteid 0.64 per cent, nitrogenous extractives 1.06 per cent, nonnitrogenous extractives 1.36 per cent, fat 0.61 per cent, and ash 0.76 per cent.

The results of these analyses of the raw and cooked meats and the broth have been calculated to the water-free basis and the values thus obtained are given in the same table (No. 3).

The quantities of the nutrients in the uncooked and cooked meats and the broth, which are soluble in water, are also given in Table 3, section B. Referring to this table, it will be seen that before cooking, the beef round used in this experiment, or a sample so similar as to be comparable, contained the following nutrients which were soluble in cold water: Proteid, 2.77 per cent; nitrogenous extractives, 1.37 per cent; nonnitrogenous extractives, 1.72 per cent; fat, none; ash, 0.98 per cent; making a total of 6.84 per cent. On the other hand, the same beef round, after cooking by boiling in water as already described, contained the following percentages of soluble nutrients: Proteid, 0.38; nitrogenous extractives, 0.33; nonnitrogenous extractives 0.45; fat, none, and ash, 0.29; making a total of only 1.45 per cent of material soluble in cold water.

In like manner the quantity of soluble constituents in the broth as actually determined by analysis is given in the same table. The amounts of the water-soluble constituents which occur in the meats and the broth have been calculated to the water-free basis, and the results are also reported in Table 3. Finally, the nutrients in the raw and cooked meats and in the broth which are insoluble in cold water are given in section C of the table.

In Table 4, giving the final results of cooking experiment No. 108,



it will be noticed that the total nutrients in the cooked meat are, water 315.43 grams; proteid, 193.88 grams; nitrogenous extractives, 1.76 grams; nonnitrogenous extractives, 2.41 grams; fat, 23.41 grams, and ash, 2.67 grams. The entire amount of water in the cooked meat was found by multiplying the weight of the cooked meat (534.54 grams) by the percentage of water (59.01) found in the cooked meat, which gave 315.43 grams. By similar calculations the weights of proteid, nitrogenous extractives, nonnitrogenous extractives, fat, and mineral matter (ash) in the entire cooked meat were obtained.

In the next line of Table 4 there is given the weight of nutrients in the broth resulting from the cooking of meat No. 1641. These values, with the exception of the data for water, were obtained directly by the chemical analysis of the original complete broth. In other words, by analysis of the entire broth resulting in this experiment, it was found that it contained 6.42 grams of proteid, 10.63 grams of nitrogenous extractives, 13.59 grams of nonnitrogenous extractives, 6.09 grams of fat, and 7.57 grams of ash. The sum of these five quantities, 44.30 grams, represents the total nutrients in the entire broth. This quantity, subtracted from 465.46 grams, the total loss in weight resulting in cooking, gives 421.16 grams, the amount of water removed from the meat during the cooking.

In the third line of Table 4 are given the weights of the nutrients in the uncooked meat used in experiment No. 108. These data were obtained by adding the weight of each nutrient in the cooked meat to the weight of each nutrient found in the broth. The uncooked meat (No. 1640) weighing 1,000 grams, may therefore be said to contain 736.59 grams of water, 200.30 grams of proteid, 12.39 grams of nitrogenous extractives, 16 grams of nonnitrogenous extractives, 29.50 grams of fat, and 10.24 grams of ash. It should be noted that these figures are obtained by computation from the analyses of cooked meat and broth from sample No. 1641, rather than by direct analysis of sample No. 1640. But by comparing them with the percentages obtained by direct analysis of sample No. 1640, given in Table No. 3, it will be seen that the differences are so slight as to be practically negligible.

The tabulated statement of the several experiments also shows the amount of each nutrient remaining in the cooked meat, and the amount of each nutrient found in the resulting broth, expressed in percentages of the total weight of each nutrient contained in the original meat. Thus in the experiment in question, No. 108, the weight of water (315.43 grams) found in the cooked meat was divided by the total weight of water (736.59 grams) contained in the uncooked meat and then multiplied by 100, which gave the percentage of water (42.82) originally contained in the uncooked meat, which still remained in the cooked meat. In the same way, the percentage of water contained in

the broth or removed during the cooking was obtained by dividing the weight of water (421.16 grams) found in the broth by the total weight of water (736.59 grams) contained in the uncooked meat and then multiplying by 100.

Similar calculations serve to show the percentages of proteid, nitrogenous extractives, nonnitrogenous extractives, fat, and ash remaining in the uncooked meat, and the percentages of these same nutrients which enter the broth during the cooking. In this experiment (p. 24) the following percentages of nutrients of the original uncooked meat were found in the cooked product: Water 42.82, proteid 96.79, nitrogenous extractives 14.20, nonnitrogenous extractives 15.06, fat 79.35, and ash 26.07. The broth contained the following percentages of the nutrients of the original uncooked meat: Water 57.18, proteid 3.21, nitrogenous extractives 85.80, nonnitrogenous extractives 84.94, fat 20.65, and ash 73.93.

Finally, the table for each experiment gives the percentage of total amounts of each nutrient in the uncooked meat which is found in the broth. Again, referring to experiment No. 108, the last row of figures in Table 4 gives these data. For example, the weight of water (421.16 grams) in the broth is divided by the weight of the uncooked meat (1,000 grams), and the quotient multiplied by 100 gives the percentage of water (42.12) which is removed by cooking, calculated on the basis of the total weight of uncooked meat. In the same manner, by dividing the weight of proteid (6.42 grams) in the broth by the weight of the uncooked meat (1,000 grams) and multiplying the quotient by 100, the product 0.64 represents the percentage amount of nitrogenous matter in the broth in terms of the weight of the uncooked meat.

## COOKING EXPERIMENTS NOS. 107-157.

Each series of experiments is preceded by a short statement giving its purpose and general plan. The individual experiments then follow, and the kind and amount of meat used, the method and time of cooking, and any other necessary facts or observations are in every case recorded in full. Preceding the tabular statement of the details of each experiment, is a paragraph giving the weight of the raw and the cooked meat, and the actual and percentage loss of weight resulting from the cooking.

### MEATS COOKED BY BOILING.

#### SERIES I.—EXPERIMENT No. 107.

In this experiment the meat was cooked in water kept at the boiling point. The lean beef round which was used was freed from all bone and visible gristle and fat, cut into pieces 0.5 to 0.75 inch thick and 0.75 inch to 1.25 inches long and after being thoroughly mixed was divided

into two portions; one (sample No. 1639) being cooked and the other (No. 1637) analyzed raw. Investigations made in this laboratory have shown that by such treatment two samples of meat practically alike in chemical composition may with care be obtained from the same cut. The first portion, cut into cubes (sample No. 1639), was placed in 2,000 cubic centimeters of vigorously boiling distilled water. The addition of the meat reduced the temperature of the water to 90° C., but it was raised to the boiling point again in five minutes, and the cooking continued for five hours and fifteen minutes at this temperature. The fibers of the cooked meat had a slightly pink color, and separated very easily, but were tough and not easily cut through. During the cooking a considerable quantity of shreds separated and settled to the bottom of the kettle.

The weight before and after cooking was as follows:

Weight of meat before cooking.....	grams..	1,000.00
Weight of meat after cooking .....	do.....	541.36
Loss in weight in cooking.....	do.....	458.64
Loss in weight in cooking.....	per cent..	45.86

Tables 1 and 2 show the results of the experiment.

TABLE 1.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 107.*

A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
ON FRESH BASIS.									
1637	Beef, round, uncooked .....	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1639	Beef, round, cooked .....	75.53	19.01	1.08	2.22	(a)	1.19	(a)	3.390
1639	Broth (percent uncooked meat) .....	59.68	34.29	.48	1.19	(a)	.79	(a)	5.640
			.51	.89	1.25	0.74	.67	4.06	.367
ON WATER-FREE BASIS.									
1637	Beef, round, uncooked .....		77.68	4.41	9.07	(a)	4.86	(a)	13.854
1639	Beef, round, cooked .....		85.04	1.19	2.95	(a)	1.96	(a)	13.988
1639	Broth (percent uncooked meat) .....		2.10	3.63	5.11	3.03	2.72	16.59	1.499

B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1637	Beef, round, uncooked.....		2.76	1.08	2.22	0	0.98	7.04	0.790
1639	Beef, round, cooked.....		.97	.48	1.19	0	.50	3.14	.309
1639	Broth(percent uncooked meat)		.34	.89	1.25	0	.67	3.15	.339
ON WATER-FREE BASIS.									
1637	Beef, round, uncooked.....		11.27	4.41	9.07	0	4.00	28.75	3.229
1639	Beef, round, cooked.....		2.40	1.19	2.95	0	1.24	7.78	.766
1639	Broth(percent uncooked meat)		1.40	3.63	5.11	0	2.72	12.85	1.386

a Determination lost.

TABLE 1.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 107—Continued.*

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitro- gen.
				Nitrog- enous.	Non- nitrog- enous.				
ON FRESH BASIS.									
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1637	Beef, round, uncooked.....		16.25	0	0	(a)	0.21	(a)	2.600
1639	Beef, round, cooked.....		33.32	0	0	(a)	.29	(a)	5.331
1639	Broth (percent uncooked meat) .....		.17	0	0	0.74	.....	0.91	.028
ON WATER-FREE BASIS.									
1637	Beef, round, uncooked.....		66.41	0	0	(a)	.86	(a)	10.625
1639	Beef, round, cooked.....		82.64	0	0	(a)	.72	(a)	13.222
1639	Broth (percent uncooked meat) .....		.70	0	0	3.03	.....	3.73	.113

<sup>a</sup> Determination lost.TABLE 2.—*Results of cooking (boiling) experiment No. 107.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extrac- tives.		Fat.	Ash.
				Nitrog- enous.	Non- nitrog- enous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1639	In cooked meat .....	323.08	185.63	2.60	6.44	(a)	4.28
1639	In broth.....	418.03	5.15	8.88	12.50	7.42	6.66
1637	In uncooked meat .....	741.11	190.78	11.48	18.94	(a)	10.94
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1639	In cooked meat .....	43.59	97.30	22.65	34.00	(a)	39.12
1639	In broth.....	56.41	2.70	77.35	66.00	(a)	60.88
1639	In broth on basis of total weight of uncooked meat ...	41.80	.52	.89	1.25	0.74	.67

<sup>a</sup> Determination lost.

## SERIES II.—EXPERIMENTS NOS. 108, 109.

The special object of these experiments was to study and compare the chemical and nutritive changes taking place when meat is cooked (1) by putting it in boiling water for ten minutes and then cooking it at 85° C. for three hours, and (2) by allowing it to stand in cold water for one hour, gradually increasing the temperature during the following hour until it reached 85° C. and then, finally, allowing it to cook for three hours at this temperature.

## COOKING EXPERIMENT NO. 108.

The lean beef round used in experiment 108 was freed from all bone, visible gristle and fat, cut into cubes about 1 inch square, and intimately mixed.

One sample (No. 1640) was analyzed raw, the other (No. 1641), which weighed 1,000 grams, was used for the cooking test. It was placed



in 2,000 cubic centimeters of vigorously boiling distilled water for ten minutes, the temperature then allowed to drop to 85° C., and the cooking continued at this temperature for three hours.

The weight before and after cooking was as follows:

Weight of meat before cooking .....	grams..	1,000.00
Weight of meat after cooking .....	do....	534.54
Loss in weight in cooking .....	do....	465.46
Loss in weight in cooking .....	per cent..	46.55

The details of the experiment are shown in Tables 3 and 4.

TABLE 3.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 108.*

A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1640	Beef, round, uncooked .....	74.04	19.63	1.37	1.72	3.19	1.18	27.09	3.580
1641	Beef, round, cooked .....	59.01	36.27	.33	.45	4.38	.50	41.93	5.910
1641	Broth (percent uncooked meat) .....		.64	1.06	1.36	.61	.76	4.43	.444
	ON WATER-FREE BASIS.								
1640	Beef, round, uncooked .....		75.62	5.28	6.62	12.29	4.55	104.36	13.791
1641	Beef, round, cooked .....		88.48	.81	1.10	10.69	1.22	102.30	14.418
1641	Broth (percent uncooked meat) .....		2.48	4.10	5.24	2.35	2.91	17.08	1.709

B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1640	Beef, round, uncooked .....		2.77	1.37	1.72	0	0.98	6.84	0.883
1641	Beef, round, cooked .....		.38	.33	.45	0	.29	1.45	.168
1641	Broth (percent uncooked meat) .....		.22	1.06	1.36	0	.75	3.39	.376
ON WATER-FREE BASIS.									
1640	Beef, round, uncooked .....		10.68	5.28	6.62	0	3.77	26.35	3.401
1641	Beef, round, cooked .....		.93	.81	1.10	0	.71	3.55	.410
1641	Broth (percent uncooked meat) .....		.84	4.10	5.24	0	2.90	13.08	1.447

C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1640	Beef, round, uncooked .....		16.86	0	0	3.19	0.20	20.25	2.697
1641	Beef, round, cooked .....		35.89	0	0	4.38	.21	40.48	5.742
1641	Broth (percent uncooked meat) .....		.42	0	0	.61	.01	1.04	.068
ON WATER-FREE BASIS.									
1640	Beef, round, uncooked .....		64.94	0	0	12.29	.78	78.01	10.390
1641	Beef, round, cooked .....		87.55	0	0	10.69	.51	98.75	14.008
1641	Broth (percent uncooked meat) .....		1.64	0	0	2.35	.01	4.00	.262

TABLE 4.—Results of cooking (boiling) experiment No. 108.

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1641	In cooked meat .....	315.43	193.88	1.76	2.41	23.41	2.67
1641	In broth .....	421.16	6.42	10.63	13.59	6.09	7.57
1640	In uncooked meat .....	736.59	200.30	12.39	16.00	29.50	10.24
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1641	In cooked meat .....	42.82	96.79	14.20	15.06	79.35	26.07
1641	In broth .....	57.18	3.21	85.80	84.94	20.65	73.93
1641	In broth on basis of total weight of uncooked meat ...	42.12	.64	1.06	1.36	.61	.76

## COOKING EXPERIMENT No. 109.

The meat used in this experiment was from the same cut of beef round as that used in the above experiment (No. 108), and it was prepared for cooking in the same way. The method of cooking was, however, entirely different. The 1,000-gram portion, cut into cubes, was placed in 2,000 cubic centimeters of cold water and allowed to stand for one hour. The temperature of the water was then gradually increased, reaching 85° C. in one hour. The meat was then cooked for three hours longer at this temperature.

The weight before and after cooking was as follows:

Weight of meat before cooking .....	grams..	1,000.00
Weight of meat after cooking.....	do.....	517.48
Loss in weight in cooking.....	do.....	482.52
Loss in weight in cooking.....	per cent..	48.25

The results of the experiment are shown in Tables 5 and 6.

TABLE 5.—Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 109.

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1640	Beef, round, uncooked.....	74.04	19.63	1.37	1.72	3.19	1.18	27.09	3.580
1642	Beef, round, cooked.....	59.91	35.20	.43	.56	3.93	.51	40.63	5.770
1642	Broth(percent uncooked meat) .....		1.56	1.02	1.34	.59	.77	5.28	.576
	ON WATER-FREE BASIS.								
1640	Beef, round, uncooked.....		75.62	5.28	6.62	12.29	4.55	104.36	13.791
1642	Beef, round, cooked.....		87.80	1.07	1.40	9.80	1.27	101.34	14.393
1642	Broth(percent uncooked meat) .....		6.00	3.93	5.16	2.29	2.98	20.36	2.220

TABLE 5.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 109—Continued.*

## B. NUTRIENTS SOLUBLE IN COLD WATER.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1640	Beef, round, uncooked.....		2.77	1.37	1.72	0	0.98	6.84	0.883
1642	Beef, round, cooked.....		.13	.43	.56	0	.27	1.39	.160
1642	Broth (percent uncooked meat) .....		.17	1.02	1.34	0	.77	3.30	.355
	ON WATER-FREE BASIS.								
1640	Beef, round, uncooked.....		10.68	5.28	6.62	0	3.77	26.35	3.402
1642	Beef, round, cooked.....		.35	1.07	1.40	0	.67	3.49	.399
1642	Broth (percent uncooked meat) .....		.66	3.93	5.16	0	2.98	12.73	1.367

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1640	Beef, round, uncooked.....	16.86	0	0	3.19	0.20	20.25	2.697	
1642	Beef, round, cooked.....	35.07	0	0	3.93	.24	39.24	5.610	
1642	Broth (percent uncooked meat) .....	1.39	0	0	.59	.....	1.98	.221	
ON WATER-FREE BASIS.									
1640	Beef, round, uncooked.....	64.94	0	0	12.29	.78	78.01	10.389	
1642	Beef, round, cooked.....	87.45	0	0	9.80	.60	97.85	13.994	
1642	Broth (percent uncooked meat) .....	5.34	0	0	2.29	.....	7.63	.853	

TABLE 6.—*Results of cooking (boiling) experiment No. 109.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
1642	Weight of nutrients:	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
1642	In cooked meat .....	310.02	182.15	2.23	2.90	20.34	2.64
1642	In broth.....	429.69	15.57	10.21	13.38	5.94	7.73
1640	In uncooked meat.....	739.71	197.72	12.44	16.28	26.28	10.37
1642	Proportion of nutrients:	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per ct.
1642	In cooked meat .....	41.91	92.13	17.93	17.81	77.40	25.46
1642	In broth.....	58.09	7.87	82.07	82.19	22.60	74.54
1642	In broth on basis of total weight of uncooked meat ...	42.97	1.56	1.02	1.34	.59	.77

## SERIES III.—EXPERIMENTS NOS. 110–113.

The four experiments in this series were all made with the same cut of meat, the object being to determine the nature of the changes in composition and nutritive value and the losses involved when meat is cooked (1) in boiling water for the entire period; (2) in boiling water for ten minutes and then at 85° C.; (3) by immersing it in cold water and warming gradually, taking one hour to raise the temperature to 85° C. and completing the cooking at this temperature, and (4) by immersing it in cold water and warming gradually, taking one hour to reach a temperature of 65° C., and completing the cooking at 64 to 65° C. The entire cut of fresh lean beef round was freed from all bone, visible

gristle, and most of the visible fat, cut into pieces 0.5 to 0.75 inch thick and from 0.75 to 1.25 inches long, and thoroughly mixed. Four samples (Nos. 1643, 1644, 1645, and 1646) were used for the four following cooking experiments and one (No. 1647) was analyzed raw.

#### COOKING EXPERIMENT No. 110.

The first portion, weighing 1,000 grams, was cut into cubes and cooked by plunging it into 2,000 cubic centimeters of vigorously boiling distilled water. The meat was then cooked for five hours in gently boiling water.

The losses in weight during cooking were as follows:

Weight of meat before cooking.....	grams..	1,000.00
Weight of meat after cooking.....	do....	547.51
Loss in weight in cooking.....	do....	452.49
Loss in weight in cooking.....	per cent..	45.25

Tables 7 and 8 give the details of the experiment.

TABLE 7.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 110.*

#### A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Pro- teid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitro- gen.
				Nitrog- enous.	Non- nitrog- enous.				
ON FRESH BASIS.									
1647	Beef, round, uncooked .....	<i>Per ct.</i> 74.18	<i>Per ct.</i> 18.11	<i>Per ct.</i> 1.41	<i>Per ct.</i> 1.95	<i>Per ct.</i> 4.28	<i>Per ct.</i> 1.28	<i>Per ct.</i> 27.03	<i>Per ct.</i> 3.350
1643	Beef, round, cooked .....	60.52	32.68	.44	.57	5.66	.74	40.09	5.370
1643	Broth (percent uncooked meat) .....		.62	.88	1.09	.85	.64	4.08	.379
ON WATER-FREE BASIS.									
1647	Beef, round, uncooked .....		70.14	5.46	7.55	16.58	4.96	104.69	12.979
1643	Beef, round, cooked .....		82.78	1.12	1.44	14.34	1.87	101.55	13.602
1643	Broth (percent uncooked meat) .....		2.40	3.39	4.23	3.28	2.47	15.77	1.469

#### B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1647	Beef, round, uncooked .....	1.82	1.41	1.95	0	0.94	6.12	0.744	
1643	Beef, round, cooked .....	.92	.44	.57	0	.44	2.37	.288	
1643	Broth(percent uncooked meat) .....	.41	.88	1.09	0	.64	3.02	.346	
ON WATER-FREE BASIS.									
1647	Beef, round, uncooked .....	7.05	5.46	7.55	0	3.64	23.70	2.881	
1643	Beef, round, cooked .....	2.33	1.12	1.44	0	1.11	6.00	.729	
1643	Broth(percent uncooked meat) .....	1.57	3.39	4.23	0	2.47	11.66	1.339	

#### C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.								
1647	Beef, round, uncooked.....	16.29	0	0	4.28	0.34	20.91	2.606
1643	Beef, round, cooked.....	31.76	0	0	5.66	.30	37.72	5.082
1643	Broth(percent uncooked meat).....	.21	0	0	.85	.....	1.06	.033
ON WATER-FREE BASIS.								
1647	Beef, round, uncooked.....	63.09	0	0	16.58	1.32	80.99	10.098
1643	Beef, round, cooked.....	80.45	0	0	14.34	.76	95.55	12.873
1643	Broth(percent uncooked meat).....	.83	0	0	3.28	.....	4.11	.130

TABLE 8.—*Results of cooking (boiling) experiment No. 110.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1643	In cooked meat.....	331.35	178.93	2.41	3.12	30.99	4.05
1643	In broth.....	411.77	6.18	8.76	10.92	8.48	6.38
1647	In uncooked meat.....	743.12	185.11	11.17	14.04	39.47	10.43
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
1643	In cooked meat.....	44.59	96.66	21.58	22.22	78.52	38.83
1643	In broth.....	55.41	3.34	78.42	77.78	21.48	61.17
1643	In broth on basis of total weight of uncooked meat...	41.18	.62	.88	1.09	.85	.64

## COOKING EXPERIMENT NO. 111.

In this experiment the 1,000 grams of meat was cut into cubes and placed in vigorously boiling distilled water. The temperature of the water was maintained at the boiling point for ten minutes, when the lamp was removed and the temperature allowed to fall to 85° C. The cooking was further continued for five hours at a temperature varying between 84° and 85° C.

The losses in weight during cooking were as follows:

Weight of meat before cooking.....	grams...	1,000.00
Weight of meat after cooking.....	do...	530.59
Loss in weight in cooking.....	do...	469.41
Loss in weight in cooking.....	per cent..	46.94

The results of the experiment are shown in Tables 9 and 10.

TABLE 9.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 111.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1647	Beef, round, uncooked.....	74.18	18.11	1.41	1.95	4.28	1.28	27.03	3.350
1644	Beef, round, cooked.....	59.12	34.14	.40	.57	5.75	.69	41.55	5.590
1644	Broth (percent uncooked meat).....		.56	.92	1.20	.85	.70	4.23	.384
	ON WATER-FREE BASIS.								
1647	Beef, round, uncooked.....		70.14	5.46	7.55	16.58	4.96	104.69	12.979
1644	Beef, round, cooked.....		83.51	.98	1.39	14.07	1.69	101.64	13.674
1644	Broth (percent uncooked meat).....		2.18	3.55	4.63	3.29	2.71	16.36	1.487



TABLE 9.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No 111—Continued.*

## B. NUTRIENTS SOLUBLE IN COLD WATER.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1647	Beef, round, uncooked.....		1.82	1.41	1.95	0	0.94	6.12	0.744
1644	Beef, round, cooked.....		.29	.40	.57	0	.38	1.64	.174
1644	Broth(percent uncooked meat) .....		.22	.92	1.20	0	.70	3.04	.329
	ON WATER-FREE BASIS.								
1647	Beef, round, uncooked.....		7.05	5.46	7.55	0	3.64	23.70	2.881
1644	Beef, round, cooked.....		.71	.98	1.39	0	.93	4.01	.425
1644	Broth(percent uncooked meat) .....		.85	3.55	4.63	0	2.71	11.74	1.274

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1647	Beef, round, uncooked.....		16.29	0	0	4.28	0.34	20.91	2.606
1644	Beef, round, cooked.....		33.85	0	0	5.75	.31	39.91	5.416
1644	Broth(percent uncooked meat) .....		.34	0	0	.85	.....	1.19	.045
ON WATER-FREE BASIS.									
1647	Beef, round, uncooked.....		63.09	0	0	16.58	1.32	80.99	10.098
1644	Beef, round, cooked.....		82.80	0	0	14.07	.76	97.63	13.249
1644	Broth(percent uncooked meat) .....		1.33	0	0	3.29	.....	4.62	.213

TABLE 10.—*Results of cooking (boiling) experiment No. 111.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1644	In cooked meat .....	313.68	181.14	2.12	3.02	30.51	3.66
1644	In broth.....	427.17	5.64	9.16	11.95	8.50	6.99
1647	In uncooked meat.....	740.85	186.78	11.28	14.97	39.01	10.65
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1644	In cooked meat .....	42.34	96.98	18.79	20.18	78.21	34.37
1644	In broth.....	57.66	3.02	81.21	79.82	21.79	65.64
1644	In broth on basis of total weight of uncooked meat...	42.72	.56	.92	1.20	.85	.70

## COOKING EXPERIMENT No. 112.

The beef round in the form of cubes was cooked by placing the entire portion of 1,000 grams in 2,000 cubic centimeters of cold water. The water surrounding the meat was gently warmed, one hour being required to raise its temperature to 85° C. The cooking was then continued further at 85° C. for five hours.

The losses in weight during cooking were as follows:

Weight of meat before cooking.....	grams..	1,000.00
Weight of meat after cooking.....	do....	503.59
Loss in weight in cooking.....	do....	496.41
Loss in weight in cooking.....	per cent..	49.64

The details of the experiment are shown in Tables 11 and 12.

TABLE 11.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 112.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitro- gen.
				Nitrog- enous.	Non- nitrog- enous.				
ON FRESH BASIS.									
1647	Beef, round, uncooked.....	<i>Per ct.</i> 74.18	<i>Per ct.</i> 18.11	<i>Per ct.</i> 1.41	<i>Per ct.</i> 1.95	<i>Per ct.</i> 4.28	<i>Per ct.</i> 1.28	<i>Per ct.</i> 27.03	<i>Per ct.</i> 3.350
1645	Beef, round, cooked.....	59.84	33.23	.32	.43	5.23	.54	39.75	5.420
1645	Broth(percent uncooked meat)	.....	.80	.99	1.27	1.14	.72	4.92	.446
ON WATER-FREE BASIS.									
1647	Beef, round, uncooked.....	.....	70.14	5.46	7.55	16.58	4.96	104.69	12.979
1645	Beef, round, cooked.....	.....	82.74	.80	1.07	13.02	1.34	98.97	13.496
1645	Broth(percent uncooked meat)	.....	3.10	3.84	4.91	4.42	2.80	19.07	1.726

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1647	Beef, round, uncooked.....		1.82	1.41	1.95	0	0.94	6.12	0.744
1645	Beef, round, cooked.....		.36	.32	.43	0	.34	1.45	.161
1645	Broth(percent uncooked meat)		.15	.99	1.27	0	.72	3.13	.341
ON WATER-FREE BASIS.									
1647	Beef, round, uncooked.....		7.05	5.46	7.55	0	3.64	23.70	2.881
1645	Beef, round, cooked.....		.89	.80	1.07	0	.84	3.59	.401
1645	Broth(percent uncooked meat)		.57	3.84	4.91	0	2.80	12.12	1.321

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1647	Beef, round, uncooked.....		16.29	0	0	4.28	0.34	20.91	2.606
1645	Beef, round, cooked.....		32.87	0	0	5.23	.20	38.30	5.259
1645	Broth(percent uncooked meat)		.65	0	0	1.14	.....	1.79	.105
ON WATER-FREE BASIS.									
1647	Beef, round, uncooked.....		63.09	0	0	16.58	1.32	80.99	10.098
1645	Beef, round, cooked.....		81.85	0	0	13.02	.50	95.37	13.095
1645	Broth(percent uncooked meat)		2.53	0	0	4.42	.....	6.95	.405

TABLE 12.—*Results of cooking (boiling) experiment No. 112.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
1645	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1645	In cooked meat .....	301.35	167.34	1.61	2.17	26.34	2.72
1645	In broth.....	447.18	8.00	9.90	12.67	11.42	7.24
1647	In uncooked meat.....	748.53	175.34	11.51	14.84	37.76	9.96
1645	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1645	In cooked meat .....	40.26	95.44	13.99	14.62	69.76	27.31
1645	In broth.....	59.74	4.66	86.01	85.38	30.24	72.69
1646	In broth on basis of total weight of uncooked meat...	44.72	.80	.99	1.27	1.14	.72

## COOKING EXPERIMENT No. 113.

The meat cut into cubes was placed in 2,000 cubic centimeters of cold water which was warmed very slowly, requiring one hour to reach 65° C. The cooking was then continued at 64 to 66° C. for five hours.

The losses in weight during the cooking were as follows:

Weight of meat before cooking .....	grams..	1, 000. 00
Weight of meat after cooking .....	do.....	548. 61
Loss in weight in cooking .....	do.....	451. 39
Loss in weight in cooking .....	per cent..	45. 14

The detailed results of the experiment are shown in Tables 13 and 14.

TABLE 13.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 113.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1647	Beef, round, uncooked .....	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1646	Beef, round, cooked .....	74.18	18.11	1.41	1.95	4.28	1.28	27.03	3.350
1646	Broth(percent uncooked meat) .....	62.93	32.16	.29	.38	5.57	.55	38.95	5.240
			.91	.92	1.19	.70	.74	4.46	.439
	ON WATER-FREE BASIS.								
1647	Beef, round, uncooked .....	70.14	5.46	7.55	16.58	4.96	104.69	12.979	
1646	Beef, round, cooked .....	86.76	.78	1.03	15.03	1.03	105.08	14.135	
1646	Broth(percent uncooked meat) .....	3.51	3.55	4.63	2.71	2.86	17.26	1.701	

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1647	Beef, round, uncooked .....	1.82	1.41	1.95	0	0.94	6.12	0.744	
1646	Beef, round, cooked .....	.27	.29	.38	0	.24	1.18	.138	
1646	Broth(percent uncooked meat) .....	.23	.92	1.19	0	.74	3.08	.331	
ON WATER-FREE BASIS.									
1647	Beef, round, uncooked .....	7.05	5.46	7.55	0	3.64	23.70	2.881	
1646	Beef, round, cooked .....	.73	.78	1.03	0	.65	3.19	.372	
1646	Broth(percent uncooked meat) .....	.90	3.55	4.63	0	2.86	11.94	1.283	

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1647	Beef, round, uncooked .....	16.29	0	0	4.28	0.34	20.91	2.606	
1646	Beef, round, cooked .....	31.89	0	0	5.57	.31	37.77	5.102	
1646	Broth(percent uncooked meat) .....	.68	0	0	.70	.....	1.38	.108	
ON WATER-FREE BASIS.									
1647	Beef, round, uncooked .....	63.09	0	0	16.58	1.32	80.99	10.098	
1646	Beef, round, cooked .....	86.03	0	0	15.03	.83	101.89	13.763	
1646	Broth(percent uncooked meat) .....	2.61	0	0	2.71	.....	5.32	.418	



TABLE 14.—Results of cooking (boiling) experiment No 113.

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1646	In cooked meat .....	345.24	176.43	1.59	2.08	30.56	3.02
1646	In broth .....	406.83	9.06	9.18	11.94	7.00	7.38
1647	In uncooked meat .....	752.07	185.49	10.77	14.02	37.56	10.40
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1646	In cooked meat .....	45.91	95.12	14.76	14.84	81.36	29.04
1646	In broth .....	54.09	4.88	85.24	85.16	18.64	70.96
1646	In broth on basis of total weight of uncooked meat...	40.68	.91	.92	1.19	.70	.74

## SERIES IV.—EXPERIMENTS NOS. 131, 132.

The special object of these two experiments was to determine the nature and amount of losses and the character of the changes which lean beef round undergoes when cooked in hot water (1) at 85° C.—that is, at a temperature considerably lower than that of boiling water—and (2) at the temperature of boiling water. Lean beef round was selected, and all the bone and visible gristle but none of the fat was removed. The entire portion was cut into small pieces, 0.5 to 0.75 inch thick and 0.75 inch to 1.25 inches long, and was then very thoroughly mixed. Three samples were then taken, two (Nos. 1720 and 1721) for the cooking test and one (No. 1722) for an analysis of the raw meat.

## COOKING EXPERIMENT No. 131.

In the first experiment, No. 131, the meat was plunged into 2,000 cubic centimeters of vigorously boiling water and cooked at the boiling point of water for ten minutes, when the temperature was allowed to drop to 85° C. and the cooking continued until the total time of cooking equaled five hours.

The losses in weight during cooking were as follows:

Weight of meat before cooking .....	grams..	1,000.00
Weight of meat after cooking .....	do....	551.91
Loss in weight in cooking .....	do....	448.09
Loss in weight in cooking .....	per cent..	44.81

Tables 15 and 16 show the details of the experiment.

TABLE 15.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 131.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1722	Beef, round, uncooked.....	<i>Per ct.</i> 72.57	<i>Per ct.</i> 18.96	<i>Per ct.</i> 1.12	<i>Per ct.</i> 1.99	<i>Per ct.</i> 4.78	<i>Per ct.</i> 1.09	<i>Per ct.</i> 27.94	<i>Per ct.</i> 3.392
1720	Beef, round, cooked.....	55.31	31.88	.65	.15	11.61	.51	44.80	5.309
1720	Broth(percent uncookedmeat)	.....	.42	.95	1.34	1.26	.64	4.61	.372
	ON WATER-FREE BASIS.								
1722	Beef, round, uncooked.....	.....	69.12	4.08	7.25	17.43	3.97	101.85	12.366
1720	Beef, round, cooked.....	.....	71.34	1.45	.34	25.98	1.14	100.25	11.880
1720	Broth(percent uncookedmeat)	.....	1.55	3.46	4.87	4.61	2.33	16.82	1.356

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1722	Beef, round, uncooked.....		2.70	1.12	1.99	0	0.89	6.70	0.791
1720	Beef, round, cooked.....		.16	.65	.15	0	.25	1.21	.234
1720	Broth (percent uncooked meat)		.28	.95	1.34	0	.64	3.21	.350
ON WATER-FREE BASIS.									
1722	Beef, round, uncooked.....		9.86	4.08	7.25	0	3.25	24.44	2.885
1720	Beef, round, cooked.....		.36	1.45	.34	0	.57	2.72	.524
1720	Broth (percent uncooked meat)		1.05	3.46	4.87	0	2.32	11.70	1.276

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1722	Beef, round, uncooked.....		16.26	0	0	4.78	0.20	21.24	2.601
1720	Beef, round, cooked.....		31.72	0	0	11.61	.26	43.59	5.075
1720	Broth (percent uncooked meat)		.14	0	0	1.26		1.40	.022
ON WATER-FREE BASIS.									
1722	Beef, round, uncooked.....		59.26	0	0	17.43	.72	77.41	9.481
1720	Beef, round, cooked.....		70.98	0	0	25.98	.57	97.53	11.356
1720	Broth (percent uncooked meat)		.50	0	0	1.61	.01	5.12	.080

TABLE 16.—*Results of cooking (boiling) experiment No. 131.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1720	In cooked meat .....	305.26	175.95	3.59	0.83	64.08	2.81
1720	In broth .....	401.97	4.24	9.49	13.36	12.64	6.39
1722	In uncooked meat.....	707.23	180.19	13.08	14.19	76.72	9.20
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1720	In cooked meat .....	43.16	97.65	27.45	5.85	83.52	30.54
1720	In broth .....	56.84	2.35	72.55	94.15	16.48	69.46
1720	In broth on basis of total weight of uncooked meat ...	40.20	.42	.95	1.34	1.26	.64

## COOKING EXPERIMENT No. 132.

The meat used in this experiment was placed directly in 2,000 cubic centimeters of vigorously boiling water and cooked at this temperature for five hours.

The losses in weight during cooking were as follows:

Weight of meat before cooking .....	grams..	1,000.00
Weight of meat after cooking .....	do....	549.72
Loss in weight in cooking .....	do....	450.28
Loss in weight in cooking .....	per cent..	45.03

The details of the experiment are recorded in Tables 17 and 18.

TABLE 17.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 132.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1722	Beef, round, uncooked.....	<i>Per ct.</i> 72.57	<i>Per ct.</i> 18.96	<i>Per ct.</i> 1.12	<i>Per ct.</i> 1.99	<i>Per ct.</i> 4.78	<i>Per ct.</i> 1.09	<i>Per ct.</i> 27.94	<i>Per ct.</i> 3.392
1721	Beef, round, cooked.....	57.12	31.98	.65	.50	9.01	.63	42.77	5.324
1721	Broth (percent uncooked meat) .....		.71	.88	1.27	1.14	.59	4.59	.895
	ON WATER-FREE BASIS.								
1722	Beef, round, uncooked.....		69.12	4.08	7.25	17.43	3.97	101.85	12.366
1721	Beef, round, cooked.....		74.58	1.51	1.17	21.01	1.47	99.74	12.416
1721	Broth (percent uncooked meat) .....		2.57	3.21	4.64	4.14	2.15	16.71	1.441

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1722	Beef, round, uncooked.....		2.70	1.12	1.99	0	0.89	6.70	0.791
1721	Beef, round, cooked.....		.56	.65	.50	0	.38	2.09	.297
1721	Broth (percent uncooked meat) .....		.60	.88	1.27	0	.59	3.34	.379
ON WATER-FREE BASIS.									
1722	Beef, round, uncooked.....		9.86	4.08	7.25	0	3.25	24.44	2.885
1721	Beef, round, cooked.....		1.31	1.51	1.17	0	.90	4.89	.694
1721	Broth (percent uncooked meat) .....		2.19	3.21	4.64	0	2.15	12.19	1.380

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1722	Beef, round, uncooked.....		16.26	0	0	4.78	0.20	21.24	2.601
1721	Beef, round, cooked.....		31.42	0	0	9.01	.25	40.68	5.027
1721	Broth (percent uncooked meat) .....		.11	0	0	1.14	.....	1.25	.016
ON WATER-FREE BASIS.									
1722	Beef, round, uncooked.....		59.26	0	0	17.43	.72	77.41	9.481
1721	Beef, round, cooked.....		73.27	0	0	21.01	.57	94.85	11.722
1721	Broth (percent uncooked meat) .....		.88	0	0	4.14	.....	4.52	.061

TABLE 18.—*Results of cooking (boiling) experiment No. 132.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1721	In cooked meat .....	314.00	175.80	3.57	2.75	49.53	3.46
1721	In broth .....	404.42	7.05	8.81	12.74	11.35	5.91
1722	In uncooked meat .....	718.42	182.85	12.38	15.49	60.88	9.37
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1721	In cooked meat .....	43.71	96.14	28.84	17.75	81.36	36.93
1721	In broth .....	56.29	3.86	71.16	82.25	18.64	63.07
1721	In broth on basis of total weight of uncooked meat ...	40.44	.71	.88	1.27	1.14	.59

## SERIES V.—EXPERIMENTS NOS. 125, 126.

The special object in these experiments was to study the changes produced in fat beef rump by cooking in water (1) at 85° C.—that is, considerably under the boiling point of water—and (2) at the boiling point of water. Before cooking, the beef rump was freed from all bone and gristle but none of the fat was removed. It was then divided into pieces, 0.5 to 0.75 inch thick and 0.75 inch to 1.25 inches long. After a thorough mixing, two portions (Nos. 1703 and 1704) each weighing 1,000 grams, were taken for cooking, while a third (No. 1705) was reserved for analysis.

## COOKING EXPERIMENT No. 125.

The first portion in the test, the cubes of meat (sample No. 1703) were placed in 2,000 cubic centimeters of vigorously boiling water. The temperature was kept at 99.5° C. for ten minutes, then allowed to drop to 85° C., at which temperature the cooking continued until the meat had been cooked for five hours in all.

The losses in weight in cooking were as follows:

Weight of meat before cooking .....	grams..	1,000.00
Weight of meat after cooking .....	do....	595.32
Loss in weight in cooking .....	do....	404.68
Loss in weight in cooking .....	per cent..	40.47

Tables 19 and 20 give the details of the experiment.

TABLE 19.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 125.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1705	Beef, rump, uncooked .....	<i>Per ct.</i> 61.22	<i>Per ct.</i> 17.71	<i>Per ct.</i> .....	<i>Per ct.</i> .....	<i>Per ct.</i> 20.23	<i>Per ct.</i> 0.91	<i>Per ct.</i> 38.85	<i>Per ct.</i> 2.834
1703	Beef, rump, cooked .....	48.34	27.13	0.29	0.34	23.36	.43	51.55	4.433
1703	Broth(percent uncooked meat) .....	.....	.45	.86	1.03	2.36	.59	5.29	.348
	ON WATER-FREE BASIS.								
1705	Beef, rump, uncooked.....	.....	45.67	.....	.....	52.17	2.35	100.19	7.308
1703	Beef, rump, cooked .....	.....	52.52	.56	.66	45.22	.83	99.79	8.581
1703	Broth(percent uncooked meat) .....	.....	1.15	2.23	2.65	6.08	1.53	13.64	.897

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1705	Beef, rump, uncooked .....	.....	.....	.....	.....	.....	.....	.....	.....
1703	Beef, rump, cooked .....	.....	0.38	0.29	0.34	0	0.28	1.29	0.154
1703	Broth(percent uncooked meat) .....	.....	.34	.86	1.03	0	.59	2.82	.331
ON WATER-FREE BASIS.									
1705	Beef, rump, uncooked .....	.....	.....	.....	.....	.....	.....	.....	.....
1703	Beef, rump, cooked .....	.....	.74	.56	.66	0	.54	2.50	.297
1703	Broth(percent uncooked meat) .....	.....	.87	2.23	2.65	0	1.53	7.28	.855

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1705	Beef, rump, uncooked .....	.....	.....	.....	.....	.....	.....	.....	.....
1703	Beef, rump, cooked .....	.....	26.75	0	0	23.36	0.15	50.26	4.279
1703	Broth(percent uncooked meat) .....	.....	.11	0	0	2.36	.....	2.47	.017
ON WATER-FREE BASIS.									
1705	Beef, rump, uncooked .....	.....	.....	.....	.....	.....	.....	.....	.....
1703	Beef, rump, cooked .....	.....	51.78	0	0	45.22	.29	97.29	8.284
1703	Broth(percent uncooked meat) .....	.....	.28	0	0	6.08	.....	6.36	.042

TABLE 20.—*Results of cooking (boiling) experiment No. 125.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1703	In cooked meat .....	287.78	161.51	1.73	2.02	139.07	2.56
1703	In broth .....	351.80	4.45	8.63	10.27	23.59	5.94
1705	In uncooked meat .....	639.58	165.96	10.36	12.29	162.66	8.50
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1703	In cooked meat .....	45.00	97.32	16.70	16.44	85.50	30.12
1703	In broth .....	55.00	2.68	83.30	83.56	14.50	69.88
1703	In broth on basis of total weight of uncooked meat ...	35.18	.45	.86	1.03	2.36	.59

## COOKING EXPERIMENT No. 126.

In this test the small pieces of beef rump (sample No. 1704) were put into 2,000 cubic centimeters of vigorously boiling water and cooked for five hours.

The losses in weight during cooking were as follows:

Weight of meat before cooking .....	grams..	1,000.00
Weight of meat after cooking .....	do....	565.45
Loss in weight in cooking .....	do....	434.55
Loss in weight in cooking .....	per cent..	43.46

Tables 21 and 22 show the details of the experiment.

TABLE 21.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 126.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitro- gen.
				Nitrog- enous.	Non- nitrog- enous.				
	ON FRESH BASIS.								
1705	Beef, rump, uncooked .....	<i>Per ct.</i> 61.22	<i>Per ct.</i> 17.71	<i>Per ct.</i> .....	<i>Per ct.</i> .....	<i>Per ct.</i> 20.23	<i>Per ct.</i> 0.91	<i>Per ct.</i> 38.85	<i>Per ct.</i> 2.834
1704	Beef, rump, cooked .....	55.01	27.58	0.53	0.72	16.07	.68	45.58	4.583
1704	Broth (percent uncooked meat) .....		1.01	.75	.94	3.09	.53	6.31	.401
	ON WATER-FREE BASIS.								
1705	Beef, rump, uncooked .....		45.67	.....	.....	52.17	2.35	100.19	7.308
1704	Beef, rump, cooked .....		61.30	1.18	1.60	35.72	1.51	101.31	10.190
1704	Broth (percent uncooked meat) .....		2.61	1.92	2.43	7.96	1.36	16.28	1.035

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1705	Beef, rump, uncooked .....								
1704	Beef, rump, cooked .....		0.90	0.53	0.72	0	0.47	2.62	0.315
1704	Broth (percent uncooked meat) .....		.88	.75	.94	0	.53	3.10	.379
ON WATER-FREE BASIS.									
1705	Beef, rump, uncooked .....								
1704	Beef, rump, cooked .....		2.00	1.18	1.60	0	1.04	5.82	.699
1704	Broth (percent uncooked meat) .....		2.26	1.92	2.43	0	1.36	7.97	.979

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1705	Beef, rump, uncooked .....								
1704	Beef, rump, cooked .....		26.68	0	0	16.07	0.21	42.96	4.268
1704	Broth (percent uncooked meat) .....		.13	0	0	3.09	.....	3.21	.022
ON WATER-FREE BASIS.									
1705	Beef, rump, uncooked .....								
1704	Beef, rump, cooked .....		59.30	0	0	35.72	.47	95.49	9.491
1704	Broth (percent uncooked meat) .....		.35	0	0	7.96	.....	8.31	.056



TABLE 22.—*Results of cooking (boiling) experiment No. 126.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1704	In cooked meat.....	311.05	155.95	3.00	4.07	90.87	3.85
1704	In broth.....	371.44	10.11	7.45	9.40	30.87	5.28
1705	In uncooked meat.....	682.49	166.06	10.45	13.47	121.74	9.13
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
1704	In cooked meat.....	45.58	93.91	28.70	30.22	74.64	42.17
1704	In broth.....	54.42	6.09	71.30	69.78	25.36	57.83
1704	In broth on basis of total weight of uncooked meat...	37.14	1.01	.75	.94	3.09	.53

## SERIES VI.—EXPERIMENTS NOS. 114-116.

These three experiments were planned to determine the effect of variations in time, temperature, and procedure of cooking upon the amount and composition of the materials which pass into the broth. Lean veal leg, freed from bone, visible gristle, and most of the visible fat, was divided into pieces 0.5 to 0.75 inch thick and 0.75 to 1.25 inches long and, after thorough mixing, was divided into four samples, weighing 1,000 grams each (Nos. 1652, 1653, and 1654) for the cooking test and one (No. 1656) for analysis.

## COOKING EXPERIMENT No. 114.

The cubes of veal were plunged into vigorously boiling water and cooked for five hours in gently boiling water.

The losses in weight during cooking were as follows:

Weight of meat before cooking.....	grams..	1,000.00
Weight of meat after cooking.....	do....	591.61
Loss in weight in cooking.....	do....	408.39
Loss in weight in cooking.....	per cent..	40.84

Tables 23 and 24 show the results of the experiment in detail.

TABLE 23.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 114.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1656	Veal, leg, uncooked.....	75.97	19.17	1.26	1.94	0.96	1.15	24.48	3.470
1652	Veal, leg, cooked.....	64.73	30.95	1.12	1.67	1.59	1.01	36.34	5.310
1652	Broth(percent uncooked meat).....		.68	.67	.96	.07	.51	2.89	.323
	ON WATER-FREE BASIS.								
1656	Veal, leg, uncooked.....		79.77	5.24	8.07	3.99	4.79	101.86	14.440
1652	Veal, leg, cooked.....		87.75	3.18	4.74	4.51	2.86	103.04	15.055
1652	Broth(percent uncooked meat).....		2.84	2.78	3.99	.28	2.12	12.01	1.345

TABLE 23.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 114—Continued.*

## B. NUTRIENTS SOLUBLE IN COLD WATER.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1656	Veal, leg, uncooked.....		2.83	1.26	1.94	0	1.00	7.03	0.855
1652	Veal, leg, cooked.....		.44	1.12	1.67	0	.73	3.96	.428
1652	Broth(percent uncooked meat).....		.54	.67	.96	0	.51	2.68	.301
	ON WATER-FREE BASIS.								
1656	Veal, leg, uncooked.....		11.78	5.24	8.07	0	4.16	29.25	3.558
1652	Veal, leg, cooked.....		1.25	3.18	4.74	0	2.07	11.24	1.215
1652	Broth(percent uncooked meat).....		2.26	2.78	3.99	0	2.11	11.14	1.254

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1656	Veal, leg, uncooked.....		16.34	0	0	0.96	0.15	17.45	2.615
1652	Veal, leg, cooked.....		30.51	0	0	1.59	.28	32.38	4.882
1652	Broth(percent uncooked meat).....		.14	0	0	.07		.21	.022
ON WATER-FREE BASIS.									
1656	Veal, leg, uncooked.....		67.99	0	0	3.99	.63	72.61	10.882
1652	Veal, leg, cooked.....		86.50	0	0	4.51	.79	91.80	13.840
1652	Broth(percent uncooked meat).....		.58	0	0	.28	.01	.87	.091

TABLE 24.—*Results of cooking (boiling) experiment No. 114.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1652	In cooked meat.....	382.95	183.10	6.63	9.88	9.41	5.98
1652	In broth.....	379.55	6.81	6.68	9.58	.68	5.09
1656	In uncooked meat .....	762.50	189.91	13.31	19.46	10.09	11.07
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1652	In cooked meat.....	50.22	96.41	49.81	50.77	93.26	54.02
1652	In broth.....	49.78	3.59	50.19	49.23	6.74	45.98
1652	In broth on basis of total weight of uncooked meat ...	37.96	.68	.67	.96	.07	.51

## COOKING EXPERIMENT No. 115.

In this test the veal leg, cut into cubes, was quickly immersed in 2,000 cubic centimeters of vigorously boiling distilled water. The water was kept as near the boiling point as possible for ten minutes, the temperature then allowed to drop to 85° C., and the cooking continued at a temperature varying between 84° and 85° C.

The losses in weight during cooking were as follows:

Weight of meat before cooking.....	grams..	1,000.00
Weight of meat after cooking.....	do.....	591.06
Loss in weight in cooking.....	do.....	408.94
Loss in weight in cooking.....	per cent..	40.89

The detailed results of the experiment are shown in Tables 25 and 26.

TABLE 25.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 115.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitro- gen.
				Nitrog- enous.	Non- nitrog- enous.				
	ON FRESH BASIS.								
1656	Veal, leg, uncooked .....	<i>Per ct.</i> 75.97	<i>Per ct.</i> 19.17	<i>Per ct.</i> 1.26	1.94	0.96	1.15	24.48	3.470
1653	Veal, leg, cooked .....	66.65	32.11	.69	1.00	1.31	.75	35.86	5.360
1653	Broth (percent uncooked meat) .....		.51	.85	1.13	.06	.62	3.17	.354
	ON WATER-FREE BASIS.								
1656	Veal, leg, uncooked .....		79.77	5.24	8.07	3.99	4.79	101.86	14.440
1653	Veal, leg, cooked .....		96.28	2.07	3.00	3.93	2.25	107.53	16.072
1653	Broth (percent uncooked meat) .....		2.12	3.52	4.70	.24	2.60	13.18	1.473

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1656	Veal, leg, uncooked.....		2.83	1.26	1.94	0	1.00	7.03	0.855
1653	Veal, leg, cooked.....		.49	.69	1.00	0	.60	2.78	.301
1653	Broth (percent uncooked meat) .....		.27	.85	1.13	0	.62	2.87	.315
ON WATER-FREE BASIS.									
1656	Veal, leg, uncooked.....		11.78	5.24	8.07	0	4.16	29.25	3.558
1653	Veal, leg, cooked.....		1.47	2.07	3.00	0	1.80	8.34	.903
1653	Broth (percent uncooked meat) .....		1.14	3.52	4.70	0	2.60	11.96	1.311

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1656	Veal, leg, uncooked.....		16.34	0	0	0.96	0.15	17.45	2.615
1653	Veal, leg, cooked.....		31.62	0	0	1.31	.15	33.08	5.059
1653	Broth (percent uncooked meat) .....		.24	0	0	.06	.....	.30	.039
ON WATER-FREE BASIS.									
1656	Veal, leg, uncooked.....		67.99	0	0	3.99	.63	72.61	10.882
1653	Veal, leg, cooked.....		94.81	0	0	3.93	.45	99.19	15.169
1653	Broth (percent uncooked meat) .....		.98	0	0	.24	.....	1.22	.162

TABLE 26.—*Results of cooking (boiling) experiment No. 115.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1653	In cooked meat .....	393.94	189.79	4.08	5.91	7.74	4.43
1653	In broth .....	377.26	5.10	8.46	11.31	.57	6.24
1656	In uncooked meat .....	771.20	194.89	12.54	17.22	8.31	10.67
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1653	In cooked meat .....	51.08	97.38	32.54	34.32	93.14	41.52
1653	In broth .....	48.92	2.62	67.46	65.68	6.86	58.48
1653	In broth on basis of total weight of uncooked meat...	37.73	.51	.85	1.13	.06	.62

## COOKING EXPERIMENT No. 116.

In this test the portion of veal leg was placed in 2,000 cubic centimeters of cold water. The temperature was then gradually raised, reaching 85° C. in an hour and the cooking continued for five hours at this temperature.

The losses in weight during cooking were as follows:

Weight of meat before cooking .....	grams..	1, 000. 00
Weight of meat after cooking .....	do....	586. 78
Loss in weight in cooking .....	do....	413. 22
Loss in weight in cooking .....	per cent..	41. 32

Tables 27 and 28 show the details of the experiment.

TABLE 27.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 116.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Pro- teid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitro- gen.
				Nitrog- enous.	Non- nitrog- enous.				
	ON FRESH BASIS.								
1656	Veal, leg, uncooked.....	<i>Per ct.</i> 75.97	<i>Per ct.</i> 19.17	<i>Per ct.</i> 1.26	<i>Per ct.</i> 1.94	<i>Per ct.</i> 0.96	<i>Per ct.</i> 1.15	<i>Per ct.</i> 24.48	<i>Per ct.</i> 3.470
1654	Veal, leg, cooked.....	68.59	31.10	.29	.96	.97	.64	33.96	5.070
1654	Broth(percent uncooked meat) .....		1.01	.76	1.14	.19	.62	3.72	.404
	ON WATER-FREE BASIS.								
1656	Veal, leg, uncooked.....		79.77	5.24	8.07	3.99	4.79	101.86	14.440
1654	Veal, leg, cooked.....		99.01	.92	3.06	3.09	2.04	108.12	16.140
1654	Broth(percent uncooked meat) .....		4.21	3.15	4.73	.78	2.60	15.47	1.683

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1656	Veal, leg, uncooked.....		2.83	1.26	1.94	0	1.00	7.03	0.855
1654	Veal, leg, cooked.....		.60	.29	.96	0	.50	2.35	.189
1654	Broth(percent uncooked meat) .....		.41	.76	1.14	0	.62	2.93	.307
ON WATER-FREE BASIS.									
1656	Veal, leg, uncooked.....		11.78	5.24	8.07	0	4.16	29.25	3.558
1654	Veal, leg, cooked.....		1.89	.92	3.06	0	1.59	7.46	.602
1654	Broth(percent uncooked meat) .....		1.68	3.15	4.73	0	2.59	12.15	1.278

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1656	Veal, leg, uncooked.....		16.34	0	0	0.96	0.15	17.45	2.615
1654	Veal, leg, cooked.....		30.50	0	0	.97	.14	31.61	4.881
1654	Broth(percent uncooked meat) .....		.60	0	0	.19	.....	.79	.097
ON WATER-FREE BASIS.									
1656	Veal, leg, uncooked.....		67.99	0	0	3.99	.63	72.61	10.882
1654	Veal, leg, cooked.....		97.12	0	0	3.09	.45	100.66	15.538
1654	Broth(percent uncooked meat) .....		2.53	0	0	.78	.01	3.32	.405

TABLE 28.—*Results of cooking (boiling) experiment No. 116.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1654	In cooked meat .....	402.47	182.49	1.70	5.63	5.69	3.76
1654	In broth .....	376.05	10.12	7.56	11.37	1.88	6.24
1656	In uncooked meat .....	778.52	192.61	9.26	17.00	7.57	10.00
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1654	In cooked meat .....	51.70	94.75	18.36	33.12	75.17	37.60
1654	In broth .....	48.30	5.25	81.64	66.88	24.83	62.40
1654	In broth on basis of total weight of uncooked meat...	37.61	1.01	.76	1.14	.19	.62

## MEATS COOKED BY BOILING COMPARED WITH THOSE COOKED BY DRY HEAT.

### SERIES VII.—EXPERIMENTS NOS. 117–120.

The object of this series of four cooking experiments made with the same cut of veal was to determine the nature of the changes in nutritive value and the character and extent of the losses which take place when veal is cooked (1) by immersing in boiling water for ten minutes and then continuing the cooking at 85° C. for five hours; (2) by putting it in cold water and warming gradually, allowing one hour to reach a temperature of 85° C., and continuing the cooking at 85° C. for five hours; (3) by pan broiling for fifteen minutes, and (4) by roasting in the form of a loaf. The entire cut of fresh veal leg, after freeing it from all bone and visible gristle, was cut into pieces 0.5 to 0.75 inch thick and from 0.75 to 1.25 inches long, thoroughly mixed and divided carefully into five portions weighing 1,000 grams each, four (Nos. 1664, 1658, 1659, and 1660) to be used for the cooking tests and one (1662) for analysis.

#### COOKING EXPERIMENT NO. 117.

For this experiment one of the portions of the veal was plunged into 2,000 cubic centimeters of rapidly boiling water, the temperature kept as near the boiling point as possible for ten minutes and then allowed to fall to 85° C., at which temperature the meat was further cooked for five hours.

The losses in weight during cooking were as follows:

Weight of meat before cooking .....	grams..	1,000.00
Weight of meat after cooking .....	do....	590.40
Loss in weight in cooking .....	do....	409.60
Loss in weight in cooking .....	per cent..	40.96

The details of the experiment are recorded in Tables 29 and 30.



TABLE 29.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 117.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1662	Veal, leg, uncooked .....	<i>Per ct.</i> 75.53	<i>Per ct.</i> 18.02	<i>Per ct.</i> 1.08	<i>Per ct.</i> 1.37	<i>Per ct.</i> 3.99	<i>Per ct.</i> 1.10	<i>Per ct.</i> 25.56	<i>Per ct.</i> 3.230
1664	Veal, leg, cooked .....	61.87	29.53	.55	.77	7.77	.66	39.28	4.900
1664	Broth(percent uncooked meat) .....		.64	.78	.91	.33	.62	3.28	.351
	ON WATER-FREE BASIS.								
1662	Veal, leg, uncooked .....		73.64	4.41	5.60	16.31	4.49	104.45	13.200
1664	Veal, leg, cooked .....		77.45	1.47	1.99	20.38	1.73	103.02	12.851
1664	Broth(percent uncooked meat) .....		2.60	3.18	3.73	1.35	2.52	13.38	1.434

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1662	Veal, leg, uncooked.....		1.90	1.08	1.37	0	0.91	5.26	0.650
1664	Veal, leg, cooked.....		.32	.55	.77	0	.53	2.17	.227
1664	Broth(percent uncooked meat) .....		.50	.78	.91	0	.62	2.81	.329
ON WATER-FREE BASIS.									
1662	Veal, leg, uncooked.....		7.76	4.41	5.60	0	3.72	21.49	2.658
1664	Veal, leg, cooked.....		.84	1.47	1.99	0	1.39	5.69	.595
1664	Broth(percent uncooked meat) .....		2.04	3.18	3.73	0	2.51	11.46	1.345

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1662	Veal, leg, uncooked.....		16.12	0	0	3.99	0.19	20.30	2.580
1664	Veal, leg, cooked.....		29.21	0	0	7.77	.13	37.11	4.673
1664	Broth(percent uncooked meat) .....		.14	0	0	.33		.47	.022
ON WATER-FREE BASIS.									
1662	Veal, leg, uncooked.....		65.88	0	0	16.31	.77	82.96	10.542
1664	Veal, leg, cooked.....		76.61	0	0	20.38	.34	97.33	12.256
1664	Broth(percent uncooked meat) .....		.56	0	0	1.35	.01	1.92	.089

TABLE 30.—*Results of cooking (boiling) experiment No. 117.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
1664	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1664	In cooked meat .....	365.28	174.35	3.25	4.55	45.87	3.90
1664	In broth.....	376.88	6.36	7.77	9.12	3.31	6.16
1662	In uncooked meat.....	742.16	180.71	11.08	13.61	49.18	10.06
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1664	In cooked meat .....	49.22	96.48	29.87	32.99	93.27	38.77
1664	In broth.....	50.78	3.52	70.13	67.01	6.73	61.23
1664	In broth on basis of total weight of uncooked meat...	37.69	.64	.78	.91	.33	.62



## COOKING EXPERIMENT No. 118.

In this test one portion of the veal (sample No. 1658) was put into 2,000 cubic centimeters of cold distilled water. The temperature was gradually increased, reaching 85° C in an hour, and the cooking continued at this temperature for five hours.

The losses in weight during cooking were as follows:

Weight of meat before cooking.....	grams..	1,000.00
Weight of meat after cooking .....	do....	574.94
Loss in weight in cooking .....	do....	425.06
Loss in weight in cooking .....	per cent..	42.51

Tables 31 and 32 show the detailed results of the experiment.

TABLE 31.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 118.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1662	Veal, leg, uncooked .....	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1658	Veal, leg, cooked .....	75.53	18.02	1.08	1.37	3.99	1.10	25.56	3.230
1658	Broth (percent uncooked meat) .....	64.66	29.13	.44	.55	5.58	.59	36.29	4.800
			1.02	.79	.96	.50	.63	3.90	.417
	ON WATER-FREE BASIS.								
1662	Veal, leg, uncooked .....		73.64	4.41	5.60	16.31	4.49	104.45	13.200
1658	Veal, leg, cooked .....		82.43	1.25	1.55	15.79	1.67	102.69	13.582
1658	Broth (percent uncooked meat) .....		4.18	3.23	3.92	2.03	2.59	15.95	1.704

## B. NUTRIENTS SOLUBLE IN COLD WATER.

	ON FRESH BASIS.								
1662	Veal, leg, uncooked.....	1.90	1.08	1.37	0	0.91	5.26	0.650	
1658	Veal, leg, cooked.....	.31	.44	.55	0	.40	1.70	.190	
1658	Broth (percent uncooked meat).....	.45	.79	.96	0	.63	2.83	.326	
	ON WATER-FREE BASIS.								
1662	Veal, leg, uncooked.....	7.76	4.41	5.60	0	3.72	21.49	2.658	
1658	Veal, leg, cooked.....	.91	1.25	1.55	0	1.13	4.84	.571	
1658	Broth (percent uncooked meat).....	1.85	3.23	3.92	0	2.58	11.58	1.332	

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

	ON FRESH BASIS.								
1662	Veal, leg, uncooked .....	16.12	0	0	3.99	0.19	20.30	2.580	
1658	Veal, leg, cooked .....	28.82	0	0	5.58	.19	34.59	4.610	
1658	Broth (percent uncooked meat) .....	.57	0	0	.50	.....	1.07	.091	
	ON WATER-FREE BASIS.								
1662	Veal, leg, uncooked .....	65.88	0	0	16.31	.77	82.96	10.542	
1658	Veal, leg, cooked .....	81.52	0	0	15.79	.54	97.85	13.011	
1658	Broth (percent uncooked meat) .....	2.33	0	0	2.03	.01	4.37	.372	

TABLE 32.—Results of cooking (boiling) experiment No. 118.

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1658	In cooked meat.....	371.76	167.48	2.53	3.16	32.08	3.39
1658	In broth.....	386.02	10.22	7.91	9.60	4.98	6.33
1662	In uncooked meat.....	757.78	177.70	10.44	12.76	37.06	9.72
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1658	In cooked meat.....	49.06	94.25	24.23	24.76	86.57	34.88
1658	In broth.....	50.94	5.75	75.77	75.24	13.43	65.12
1658	In broth on basis of total weight of uncooked meat....	38.60	1.02	.79	.96	.50	.63

## COOKING EXPERIMENT NO. 119.

This is the first experiment reported in this bulletin in which the meat was cooked by pan broiling. The veal (sample No. 1655) was passed through a sausage mill three times and thoroughly mixed each time. It was then made up into cakes weighing 90 to 100 grams each and pan broiled; that is, the meat was placed in a moderately hot, dry, cast-iron pan and cooked over a gas flame for fifteen minutes, or until fairly well done, being turned frequently after it was well seared. The frying pan was not greased, nor was any fat added during the cooking. When cooked, the meat was removed from the frying pan, care being taken to scrape off any adhering material, and weighed.

The difference in weight between the raw and cooked meat showed the total loss resulting from cooking, and the difference between the amount of each ingredient in the uncooked and cooked meat was assumed to represent the losses during cooking. In the tables a loss is indicated by the minus sign (—), and an apparent gain by a plus sign (+),<sup>a</sup> as will be explained (p. 180).

The losses in weight during the cooking were as follows:

Weight of meat before cooking .....	grams..	572.72
Weight of meat after cooking .....	do....	399.37
Loss in weight in cooking .....	do....	173.35
Loss in weight in cooking .....	per cent..	30.27

The results of the experiment are shown in detail in Tables 33 and 34.

<sup>a</sup> See U. S. Dept. Agr., Office of Experiment Stations Bul. 141, p. 62 et seq.

TABLE 33.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 119.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
ON FRESH BASIS.									
1662	Veal, leg, uncooked .....	<i>Per. ct.</i> 75.53	<i>Per. ct.</i> 18.02	<i>Per. ct.</i> 1.08	<i>Per. ct.</i> 1.37	<i>Per. ct.</i> 3.99	<i>Per. ct.</i> 1.10	<i>Per. ct.</i> 25.56	<i>Per. ct.</i> 3.230
1659	Veal, leg, cooked.....	65.33	26.71	1.33	1.84	5.20	1.44	36.52	4.700
ON WATER-FREE BASIS.									
1662	Veal, leg, uncooked.....		73.64	4.41	5.60	16.31	4.50	104.46	13.200
1659	Veal, leg, cooked.....		77.04	3.84	5.31	15.00	4.15	105.34	13.556

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1662	Veal, leg, uncooked .....		1.90	1.08	1.37	0	0.91	5.26	0.650
1659	Veal, leg, cooked.....		.42	1.33	1.84	0	1.29	4.88	.494
ON WATER-FREE BASIS.									
1662	Veal, leg, uncooked .....		7.76	4.41	5.60	0	3.72	21.49	2.658
1659	Veal, leg, cooked .....		1.21	3.84	5.31	0	3.72	14.08	1.425

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1662	Veal, leg, uncooked.....		16.12	0	0	3.99	0.19	20.30	2.580
1659	Veal, leg, cooked.....		26.29	0	0	5.20	.15	31.64	4.206
ON WATER-FREE BASIS.									
1662	Veal, leg, uncooked.....		65.88	0	0	16.31	.77	82.96	10.542
1659	Veal, leg, cooked.....		75.83	0	0	15.00	.43	91.26	12.131

TABLE 34.—*Results of cooking (panbroiling) experiment No. 119.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
1662	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1659	In uncooked meat.....	432.58	103.20	6.19	7.85	22.85	6.30
	In cooked meat.....	260.90	106.67	5.31	7.35	20.77	5.75
	Lost (—) or (apparently) gained (+) .....	—171.68	+3.47	— .88	— .50	—2.08	— .55
1659	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
	In cooked meat.....	60.31	100.00	85.78	93.63	90.90	91.27
	Lost (—) or (apparently) gained (+) .....	— 39.69	+3.36	—14.22	—6.37	—9.10	—8.73
	Lost (—) or (apparently) gained (+) in percentages of weight of uncooked meat.	— 29.98	+ .61	— .15	— .09	— .36	— .10

## COOKING EXPERIMENT No. 120.

The fourth portion (sample No. 1660) of veal leg was passed through a sausage mill three times, being thoroughly mixed each time, then made into a loaf without the addition of seasoning or any other material and carefully and slowly cooked in a gas oven for three hours.

The losses in weight during the cooking were as follows:

Weight of meat before cooking .....	grams..	1,099.00
Weight of meat after cooking .....	do....	854.18
Loss in weight in cooking .....	do....	244.82
Loss in weight in cooking .....	per cent..	22.28

The details of the experiment are recorded in Tables 35 and 36.

TABLE 35.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 120.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitro- gen.
				Nitrog- enous.	Non- nitrog- enous.				
	ON FRESH BASIS.								
1662	Veal, leg, uncooked.....	<i>Per ct.</i> 75.53	<i>Per ct.</i> 18.02	<i>Per ct.</i> 1.08	<i>Per ct.</i> 1.37	<i>Per ct.</i> 3.99	<i>Per ct.</i> 1.10	<i>Per ct.</i> 25.56	<i>Per ct.</i> 3.230
1660	Veal, leg, cooked.....	68.35	23.69	1.34	1.89	4.65	1.36	32.93	4.220
	ON WATER-FREE BASIS.								
1662	Veal, leg, uncooked.....		73.64	4.41	5.60	16.31	4.50	104.46	13.200
1660	Veal, leg, cooked.....		74.85	4.23	5.97	14.69	4.30	104.04	13.333

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1662	Veal, leg, uncooked.....		1.90	1.08	1.37	0	0.91	5.26	0.650
1660	Veal, leg, cooked.....		.41	1.34	1.89	0	1.18	4.82	.496
ON WATER-FREE BASIS.									
1662	Veal, leg, uncooked.....		7.76	4.41	5.60	0	3.72	21.49	2.658
1660	Veal, leg, cooked.....		1.30	4.23	5.97	0	3.73	15.23	1.566

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1662	Veal, leg, uncooked.....		16.12	0	0	3.99	0.19	20.30	2.580
1660	Veal, leg, cooked.....		23.28	0	0	4.65	.18	28.11	3.724
ON WATER-FREE BASIS.									
1662	Veal, leg, uncooked.....		65.88	0	0	16.31	.77	82.96	10.542
1660	Veal, leg, cooked.....		73.55	0	0	14.69	.57	88.81	11.767

TABLE 36.—*Results of cooking (roasting) experiment No. 120.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1662	In uncooked meat.....	830.07	198.04	11.87	15.06	43.85	12.09
1660	In cooked meat.....	583.83	202.36	11.45	16.14	39.72	11.62
	Lost (—) or (apparently) gained (+) .....	—246.24	+4.32	— .42	+1.08	—4.13	— .47
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1660	In cooked meat.....	70.34	100.00	96.46	100.00	90.58	96.11
	Lost (—) or (apparently) gained (+) .....	— 29.66	+2.18	—3.54	+7.17	—9.42	—3.89
	Lost (—) or (apparently) gained (+) in percentages of weight of uncooked meat....	— 22.41	+ .39	— .04	+ .10	— .38	— .04

## SERIES VIII.—EXPERIMENTS NOS. 121–124.

The main object in this series of experiments was to study the losses and to determine the nature of the changes which take place when different cuts of meat—neck, flank, and rump—are cooked by boiling. Further, in one of the tests (No. 124) the meat was pan broiled for the purpose of comparing the effect of this method of cooking with boiling.

## COOKING EXPERIMENT No. 121.

In this experiment a cut of beef neck freed from all bone and visible gristle but not from the visible fat was cut into 0.7-inch cubes and thoroughly mixed. Two uniform samples were selected, one (No. 1665) for cooking and one (No. 1668) for complete chemical analysis. In the cooking test the weighed meat was placed in 2,000 cubic centimeters of vigorously boiling water, cooked for ten minutes at this temperature and for five hours at 85° C.

The losses in weight during cooking were as follows:

Weight of meat before cooking.....	grams..	700.00
Weight of meat after cooking.....	do.....	384.35
Loss in weight in cooking.....	do.....	315.65
Loss in weight in cooking .....	per cent..	45.09

Tables 37 and 38 show the details of the experiment.

TABLE 37.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 121.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1668	Beef, neck, uncooked .....	<i>Per ct.</i> 71.29	<i>Per ct.</i> 17.75	<i>Per ct.</i> 0.81	<i>Per ct.</i> 1.63	<i>Per ct.</i> 8.77	<i>Per ct.</i> 1.02	<i>Per ct.</i> 29.98	<i>Per ct.</i> 3.098
1665	Beef, neck, cooked .....	54.40	30.86	.32	.55	13.68	.47	45.88	5.039
1665	Broth (percent uncooked meat) .....		2.09	(a)	(a)	1.02	.67	(a)	.334
	ON WATER-FREE BASIS.								
1668	Beef, neck, uncooked .....		61.83	2.82	5.68	30.55	3.55	104.43	10.791
1665	Beef, neck, cooked .....		67.68	.70	1.21	30.00	1.03	100.62	11.049
1665	Broth (percent uncooked meat) .....		7.27	(a)	(a)	3.55	2.34	(a)	1.163

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1668	Beef, neck, uncooked .....		2.30	0.81	1.63	0	0.77	5.51	0.627
1665	Beef, neck, cooked .....		.19	.32	.55	0	.20	1.26	.132
1665	Broth(percent uncooked meat) .....		2.00	(a)	(a)	0	.67	2.89	.320
ON WATER-FREE BASIS.									
1668	Beef, neck, uncooked .....		8.02	2.82	5.68	0	2.68	19.20	2.183
1665	Beef, neck, cooked .....		.42	.70	1.21	0	.44	2.77	.290
1665	Broth(percent uncooked meat) .....		6.97	(a)	(a)	0	2.34	10.07	1.115

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1668	Beef, neck, uncooked .....		15.45	0	0	8.77	0.25	24.47	2.471
1665	Beef, neck, cooked .....		30.67	0	0	13.68	.27	44.62	4.907
1665	Broth(percent uncooked meat) .....		.09	0	0	1.02			.014
ON WATER-FREE BASIS.									
1668	Beef, neck, uncooked .....		53.81	0	0	30.55	.87	85.23	8.608
1665	Beef, neck, cooked .....		67.26	0	0	30.00	.59	97.85	10.759
1665	Broth(percent uncooked meat) .....		.30			3.55			.048

a Determination lost.

TABLE 38.—*Results of cooking (boiling) experiment No. 121.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1665	In cooked meat .....	209.09	118.61	1.23	2.11	52.58	1.81
1665	In broth .....	(a)	14.63	(a)	(a)	7.12	4.69
1668	In uncooked meat .....	(a)	(a)	(a)	(a)	59.70	6.50
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1665	In cooked meat .....	(a)	(a)	(a)	(a)	88.07	27.85
1665	In broth .....	(a)	(a)	(a)	(a)	11.93	72.15
1668	In broth on basis of total weight of uncooked meat...	(a)	2.09	(a)	(a)	1.02	.67

a Determination lost.



## COOKING EXPERIMENT No. 122.

In this experiment a very fat cut of beef flank was used. It was freed from all bone and visible gristle, but not from visible fat, cut into cubes of about 0.75 inch in size and thoroughly mixed. Two portions were taken—one (No. 1669) for cooking and the other (No. 1672) for analysis. In the cooking test the weighed meat was put into 2,000 cubic centimeters of vigorously boiling water, the temperature maintained as near the boiling point as possible for ten minutes, then allowed to drop to 85° C. and kept at this point until the total time of cooking equaled five hours.

The losses in weight during cooking were as follows:

Weight of meat before cooking .....	grams..	1,000.00
Weight of meat after cooking .....	do....	700.57
Loss in weight in cooking .....	do....	299.43
Loss in weight in cooking .....	per cent..	29.94

The detailed results of the experiment are shown in Tables 39 and 40.

TABLE 39.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 122.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitro- gen.
				Nitrog- enous.	Non- nitrog- enous.				
ON FRESH BASIS.									
1672	Beef, flank, uncooked .....	<i>Per ct.</i> 59.17	<i>Per ct.</i> 13.96	<i>Per ct.</i> 0.77	<i>Per ct.</i> 0.96	<i>Per ct.</i> 24.95	<i>Per ct.</i> 0.71	<i>Per ct.</i> 41.35	<i>Per ct.</i> 2.479
1669	Beef, flank, cooked .....	46.46	19.98	.04	.17	34.16	.24	54.59	3.210
1669	Broth (percent uncooked meat) .....		.70	.56	.74	6.48	.44	8.92	.292
ON WATER-FREE BASIS.									
1672	Beef, flank, uncooked .....		34.19	1.89	2.35	61.11	1.74	101.28	6.071
1669	Beef, flank, cooked .....		37.32	.07	.32	63.80	.45	101.96	5.996
1669	Broth (percent uncooked meat) .....		1.72	1.37	1.81	15.87	1.07	21.84	.715

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1672	Beef, flank, uncooked .....		1.21	0.77	0.96	0	0.55	3.49	0.440
1669	Beef, flank, cooked .....		.39	.04	.17	0	.20	.80	.077
1669	Broth (percent uncooked meat) .....		.61	.56	.74	0	.44	2.35	.278
ON WATER-FREE BASIS.									
1672	Beef, flank, uncooked .....		2.99	1.89	2.35	0	1.35	8.58	1.078
1669	Beef, flank, cooked .....		.75	.07	.32	0	.37	1.51	.144
1669	Broth (percent uncooked meat) .....		1.50	1.37	1.81	0	1.07	5.75	.680

TABLE 39.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 122—Continued.*

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1672	Beef, flank, uncooked .....		12.75	0	0	24.95	0.16	37.86	2.039
1669	Beef, flank, cooked .....		19.59	0	0	34.16	.04	53.79	3.133
1669	Broth (percent uncooked meat) .....		.09	0	0	6.48	.....	6.57	.014
	ON WATER-FREE BASIS.								
1672	Beef, flank, uncooked .....		31.20	0	0	61.11	.39	92.70	4.993
1669	Beef, flank, cooked .....		36.57	0	0	63.80	.08	100.45	5.852
1669	Broth (percent uncooked meat) .....		.22	0	0	15.87	.....	16.09	.035

TABLE 40.—*Results of cooking (boiling) experiment No. 122.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1669	In cooked meat .....	325.48	139.97	0.28	1.19	239.31	1.68
1669	In broth .....	210.26	7.00	5.61	7.38	64.81	4.37
1672	In uncooked meat .....	535.74	146.97	5.89	8.57	304.12	6.05
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1669	In cooked meat .....	60.75	95.24	4.75	13.89	78.69	27.77
1669	In broth .....	39.25	4.76	95.25	86.11	21.31	72.23
1669	In broth on basis of total weight of uncooked meat...	21.03	.70	.56	.74	6.48	.44

## COOKING EXPERIMENT NO. 123.

In this experiment very fat beef rump was cooked by the method followed in experiments Nos. 121 and 122. All the bone and gristle were removed from the meat and the entire cut was divided into pieces 0.5 to 0.75 inch thick and 0.75 to 1.25 inches long and thoroughly mixed. Three portions were then taken, two (Nos. 1673 and 1674) for cooking and one (No. 1676) for analysis in the uncooked condition. One portion (sample No. 1673) was plunged into 2,000 cubic centimeters of vigorously boiling water and kept at this temperature for ten minutes. The temperature was then allowed to drop to 85° C., at which point it was kept until the total time of cooking equaled five hours.

The losses in weight during cooking were as follows:

Weight of meat before cooking.....	grams..	1,000.00
Weight of meat after cooking.....	do.....	643.20
Loss in weight in cooking.....	do.....	356.80
Loss in weight in cooking .....	per cent..	35.68

Tables 41 and 42 give the detailed results of the experiment.

TABLE 41.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 123.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1676	Beef, rump, uncooked.....	<i>Per ct.</i> 52.26	<i>Per ct.</i> 13.69	<i>Per ct.</i> 0.66	<i>Per ct.</i> 0.88	<i>Per ct.</i> 32.38	<i>Per ct.</i> 0.74	<i>Per ct.</i> 48.35	<i>Per ct.</i> 2.400
1673	Beef, rump, cooked.....	38.35	19.34	.47	.43	42.03	.33	62.60	3.245
1673	Broth(percent uncooked meat)	.....	.51	.61	.86	6.32	.50	8.80	.275
	ON WATER-FREE BASIS.								
1676	Beef, rump, uncooked.....		28.68	1.38	1.84	67.83	1.55	101.28	5.027
1673	Beef, rump, cooked.....		31.37	.76	.70	68.18	.54	101.55	5.264
1673	Broth(percent uncooked meat)		1.06	1.27	1.79	13.24	1.04	18.40	.576

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1676	Beef, rump, uncooked.....		1.54	0.66	0.88	0	0.61	3.69	0.456
1673	Beef, rump, cooked.....		.38	.47	.43	0	.25	1.53	.212
1673	Broth(percent uncooked meat)		.32	.61	.86	0	.50	2.29	.245
ON WATER-FREE BASIS.									
1676	Beef, rump, uncooked.....		3.23	1.38	1.84	0	1.28	7.73	.955
1673	Beef, rump, cooked.....		.62	.76	.70	0	.41	2.49	.343
1673	Broth(percent uncooked meat)		.67	1.27	1.79	0	1.04	4.77	.514

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1676	Beef, rump, uncooked.....		12.15	0	0	32.38	0.13	44.66	1.944
1673	Beef, rump, cooked.....		18.96	0	0	42.03	.08	61.07	3.033
1673	Broth(percent uncooked meat)		.19	0	0	6.32	.....	6.51	.030
ON WATER-FREE BASIS.									
1676	Beef, rump, uncooked.....		25.45	0	0	67.83	0.27	93.55	4.072
1673	Beef, rump, cooked.....		30.75	0	0	68.18	.13	99.06	4.920
1673	Broth(percent uncooked meat)		.39	0	0	13.24	.....	13.63	.062

TABLE 42.—*Results of cooking (boiling) experiment No. 123.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
1673	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1673	In cooked meat .....	246.67	124.39	3.02	2.77	270.34	2.12
1673	In broth.....	268.97	5.06	6.06	8.55	63.20	4.97
1676	In uncooked meat.....	515.64	129.45	9.07	11.32	333.54	7.09
1673	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1673	In cooked meat .....	47.84	96.09	33.30	24.47	81.05	29.90
1673	In broth.....	52.16	3.91	66.70	75.53	18.95	70.10
1673	In broth on basis of total weight of uncooked meat...	26.90	.51	.61	.86	6.32	.50

## COOKING EXPERIMENT NO. 124.

For purposes of comparison a sample of beef rump (No. 1674) was pan broiled, the same cut being used as in the preceding test in which the meat was boiled. The thoroughly sampled beef was passed through a sausage mill three times, being carefully mixed each time, and then made up into cakes weighing 90 to 100 grams and pan broiled—that is, the meat was placed upon the surface of a moderately hot, dry, cast-iron pan and cooked for thirteen minutes, until fairly well done, the meat being turned frequently after it was well seared. No fat was added either before or during the cooking. When sufficiently cooked the meat was removed from the frying pan, care being taken to scrape off as much of the adhering material as possible, and then weighed.

The losses in weight during the cooking were as follows:

Weight of meat before cooking .....	grams..	571.12
Weight of meat after cooking .....	do...	368.47
Loss in weight in cooking .....	do...	202.65
Loss in weight in cooking .....	per cent..	35.48

The results of the experiment are given in detail in Tables 43 and 44.

TABLE 43.—*Constituents of uncooked meats and cooked meats, soluble and insoluble in cold water, experiment No. 124.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1676	Beef, rump, uncooked.....	52.26	13.69	0.66	0.88	32.38	0.71	48.35	2.400
1674	Beef, rump, cooked.....	27.46	21.51	1.07	1.33	47.39	1.18	72.48	3.786
	ON WATER-FREE BASIS.								
1676	Beef, rump, uncooked.....		28.68	1.38	1.84	67.83	1.55	101.28	5.027
1674	Beef, rump, cooked.....		29.65	1.48	1.83	65.33	1.63	99.92	5.218

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1676	Beef, rump, uncooked.....		1.54	0.66	0.88	0	0.61	3.69	0.456
1674	Beef, rump, cooked.....		.27	1.07	1.33	0	1.07	3.74	.387
ON WATER-FREE BASIS.									
1676	Beef, rump, uncooked.....		3.23	1.38	1.84	0	1.28	7.73	.955
1674	Beef, rump, cooked.....		.37	1.48	1.83	0	1.48	5.16	.534

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1676	Beef, rump, uncooked.....		12.15	0	0	32.38	0.13	44.66	1.944
1674	Beef, rump, cooked.....		21.24	0	0	47.39	.11	68.74	3.399
ON WATER-FREE BASIS.									
1676	Beef, rump, uncooked.....		25.45	0	0	67.83	.27	93.55	4.072
1674	Beef, rump, cooked.....		29.28	0	0	65.33	.15	94.76	4.685

TABLE 44.—*Results of cooking (pan broiling) experiment No. 124.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
1676	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1674	In uncooked meat.....	298.47	78.19	3.77	5.03	184.92	4.23
	In cooked meat.....	101.18	79.26	3.94	4.90	174.62	4.35
	Lost (—) or (apparently) gained (+).....	—197.29	+1.07	+ .17	— .13	—10.30	+ .12
1674	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
	In cooked meat.....	33.90	100.00	100.00	97.42	94.43	100.00
	Lost (—) or (apparently) gained (+).....	— 66.10	+1.37	+4.51	—2.58	— 5.57	+2.84
	Lost (—) or (apparently) gained (+) in percentages of weight of uncooked meat.	— 34.54	+ .19	+ .03	— .02	— 1.80	+ .02

## SERIES IX.—EXPERIMENTS NOS. 141-147.

This series of seven experiments was made to determine the influence of different methods of cooking (1) upon the soluble and insoluble constituents of meat, and (2) upon the nature and the quantities of nutrients lost. Lean beef round from which all bone, gristle, and most of the visible fat had been removed was used in the entire series, and was divided as follows: (1) A representative cross-section layer about one-half inch thick (sample No. 1764) was reserved for complete chemical analysis; (2) three steaks (samples Nos. 1765, 1766, and 1767), 1 inch thick, of approximately equal size and as similar as possible in appearance and composition were used in experiments Nos. 141, 142, and 143; (3) three pieces (samples Nos. 1768, 1770, and 1771), about 5 inches thick and 4 inches across and as similar as possible in appearance, shape, and size were taken for experiments Nos. 144, 146, and 147; and (4) one portion (No. 1769) was cut into 2-inch cubes for use in experiment No. 145.

## EXPERIMENT No. 141.

One of the steaks (sample No. 1765) 1 inch in thickness was sautéed. A small amount of beef fat (7.1 grams) was heated in the frying pan until it began to smoke, the meat then added and cooked for ten minutes with frequent turning. It was well browned but still underdone, or rare, and juicy.

The losses in weight during cooking were as follows:

Weight of meat before cooking .....	grams..	670.54
Weight of meat after cooking .....	do....	566.40
Loss in weight in cooking .....	do....	104.14
Loss in weight in cooking .....	per cent..	15.53

The results are given in detail in Tables 45 and 46.

TABLE 45.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 141.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1764	Beef, round, uncooked.....	<i>Per ct.</i> 69.92	<i>Per ct.</i> 17.96	<i>Per ct.</i> 1.18	<i>Per ct.</i> 1.73	<i>Per ct.</i> 8.15	<i>Per ct.</i> 1.06	<i>Per ct.</i> 30.08	<i>Per ct.</i> 3.251
1765	Beef, round, cooked.....	64.02	22.51	1.38	1.69	9.88	1.18	36.64	4.044
	ON WATER-FREE BASIS.								
1764	Beef, round, uncooked.....		59.71	3.92	5.75	27.09	3.52	99.99	10.808
1765	Beef, round, cooked.....		62.56	3.84	4.70	27.46	3.28	101.84	11.240

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1764	Beef, round, uncooked.....		2.70	1.18	1.73	0	0.73	6.34	0.811
1765	Beef, round, cooked.....		1.03	1.38	1.69	0	.94	5.04	.608
ON WATER-FREE BASIS.									
1764	Beef, round, uncooked.....		9.00	3.92	5.75	0	2.44	21.11	2.695
1765	Beef, round, cooked.....		2.87	3.84	4.70	0	2.62	14.03	1.690

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1764	Beef, round, uncooked.....		15.26	0	0	8.15	0.33	23.74	2.440
1765	Beef, round, cooked.....		21.48	0	0	9.88	.24	31.60	3.436
ON WATER-FREE BASIS.									
1764	Beef, round, uncooked.....		50.71	0	0	27.09	1.08	78.88	8.113
1765	Beef, round, cooked.....		59.69	0	0	27.46	.66	87.81	9.550

TABLE 46.—*Results of cooking (sauteing) experiment No. 141.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
1764	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1765	In uncooked meat .....	468.84	120.43	7.91	11.60	54.65	7.11
	In cooked meat .....	362.61	127.50	7.82	9.57	55.96	6.68
	Lost (—) or (apparently) gained (+) .....	—106.23	+7.07	— .09	— 2.03	+1.31	— .43
1765	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
	In cooked meat .....	77.34	100.00	98.86	82.50	100.00	93.95
	Lost (—) or (apparently) gained (+) .....	— 22.64	+5.87	—1.14	—17.50	+2.40	—6.05
	Lost (—) or (apparently) gained (+) in percentages of weight of uncooked meat.	— 15.84	+1.05	— .01	— .30	+ .20	— .06



## COOKING EXPERIMENT No. 142.

For this experiment another one of the steaks (sample No. 1766) 1 inch in thickness was pan broiled as follows: After the pan had been heated until "blue hot," that is, until the iron has a bluish and characteristic appearance which housekeepers readily recognize, the meat was put in it and cooked for ten minutes, with frequent turning, no fat being added either before or during the cooking. The cooked meat was well browned on the outside, but decidedly underdone, or rare, and juicy within.

The losses in weight during cooking were as follows:

Weight of meat before cooking .....	grams..	673.91
Weight of meat after cooking .....	do....	563.37
Loss in weight in cooking .....	do....	110.54
Loss in weight in cooking .....	per cent..	16.40

Tables 47 and 48 give the details of the experiment.

TABLE 47.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 142.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1764	Beef, round, uncooked .....	<i>Per ct.</i> 69.92	<i>Per ct.</i> 17.96	<i>Per ct.</i> 1.18	<i>Per ct.</i> 1.73	<i>Per ct.</i> 8.15	<i>Per ct.</i> 1.06	<i>Per ct.</i> 30.08	<i>Per ct.</i> 3.251
1766	Beef, round, cooked .....	65.61	22.31	1.46	1.72	8.18	1.19	34.86	4.037
	ON WATER-FREE BASIS.								
1764	Beef, round, uncooked .....		59.71	3.92	5.75	27.09	3.52	99.99	10.808
1766	Beef, round, cooked .....		64.87	4.25	5.00	23.79	3.46	101.37	11.739

## B. NUTRIENTS SOLUBLE IN COLD WATER.

	ON FRESH BASIS.								
1764	Beef, round, uncooked .....		2.70	1.18	1.73	0	0.73	6.34	0.811
1766	Beef, round, cooked .....		1.37	1.46	1.72	0	.99	5.54	.686
	ON WATER-FREE BASIS.								
1764	Beef, round, uncooked .....		9.00	3.92	5.75	0	2.44	21.11	2.695
1766	Beef, round, cooked .....		3.98	4.25	5.00	0	2.88	16.11	1.996

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

	ON FRESH BASIS.								
1764	Beef, round, uncooked .....		15.26	0	0	8.15	0.33	23.74	2.440
1766	Beef, round, cooked .....		20.94	0	0	8.18	.20	29.32	3.351
	ON WATER-FREE BASIS.								
1764	Beef, round, uncooked .....		50.71	0	0	27.09	1.08	78.88	8.113
1766	Beef, round, cooked .....		60.89	0	0	23.79	.58	85.26	9.743

TABLE 48.—*Results of cooking (pan broiling) experiment No. 142.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1764	In uncooked meat.....	471.20	121.03	7.95	11.66	54.92	7.14
1766	In cooked meat.....	369.63	125.69	8.23	9.69	46.08	6.70
	Lost (—) or (apparently) gained (+).....	—101.57	+4.66	+ .28	— 1.97	— 8.84	— .44
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1766	In cooked meat.....	78.44	100.00	100.00	83.10	83.90	93.84
	Lost (—) or (apparently) gained (+).....	— 21.56	+3.85	+3.52	—16.90	—16.10	—6.16
	Lost (—) or (apparently) gained (+) in percentages of weight of uncooked meat.	— 15.07	+ .69	+ .04	— .29	— 1.31	— .07

## COOKING EXPERIMENT No. 143.

For this experiment the third 1-inch thick steak (sample No. 1767) was cooked by frying in deep fat. A quantity of lard sufficient to entirely cover the meat was heated to 200° C. and to this the meat was quickly added. The temperature dropped at once to 160° C. The cooking was continued for five minutes. The cooked meat was well browned on the edges, but decidedly underdone, or rare, and juicy in the interior.

The losses in weight during cooking were as follows:

Weight of meat before cooking.....	grams..	666.11
Weight of meat after cooking.....	do....	471.08
Loss in weight in cooking.....	do....	195.03
Loss in weight in cooking.....	per cent..	29.28

Tables 49 and 50 show the detailed results of the experiment.

TABLE 49.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 143.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1764	Beef, round, uncooked .....	69.92	17.96	1.18	1.73	8.15	1.06	30.08	3.251
1767	Beef, round, cooked .....	57.78	27.59	1.62	1.83	10.42	1.43	42.89	4.934
	ON WATER-FREE BASIS.								
1764	Beef, round, uncooked .....		59.71	3.92	5.75	27.09	3.52	99.99	10.808
1767	Beef, round, cooked .....		65.35	3.84	4.33	24.68	3.39	101.59	11.687

TABLE 49.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 143—Continued.*

## B. NUTRIENTS SOLUBLE IN COLD WATER.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1764	Beef, round, uncooked .....	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1767	Beef, round, cooked .....		2.70	1.18	1.73	0	0.73	6.34	0.811
			.54	1.62	1.83	0	1.08	5.07	.605
	ON WATER-FREE BASIS.								
1764	Beef, round, uncooked .....		9.00	3.92	5.75	0	2.44	21.11	2.695
1767	Beef, round, cooked .....		1.26	3.84	4.33	0	2.58	12.01	1.433

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1764	Beef, round, uncooked .....		15.26	0	0	8.15	0.33	23.74	2.440
1767	Beef, round, cooked .....		27.05	0	0	10.42	.35	37.82	4.329
ON WATER-FREE BASIS.									
1764	Beef, round, uncooked .....		50.71	0	0	27.09	1.08	78.88	8.113
1767	Beef, round, cooked .....		64.09	0	0	24.68	.81	89.58	10.254

TABLE 50.—*Results of cooking (frying in lard) experiment No. 143.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
1764	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1767	In uncooked meat.....	465.74	119.63	7.86	11.52	54.29	7.06
	In cooked meat.....	272.19	129.97	7.63	8.62	49.09	6.74
	Lost (—) or (apparently) gained (+).....	—193.55	+10.34	— .23	— 2.90	—5.20	— .32
1767	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
	In cooked meat.....	58.44	100.00	97.07	74.83	90.42	95.47
	Lost (—) or (apparently) gained (+).....	—41.56	+ 8.64	—2.93	—25.17	—9.58	—4.53
	Lost (—) or (apparently) gained (+) in percentages of weight of uncooked meat.	—29.06	+ 1.55	— .03	— .44	— .78	— .05

## COOKING EXPERIMENT No. 144.

In this experiment one of the pieces of the beef round which was cut about 5 inches thick and 4 inches across (sample No. 1768) was plunged into 2,000 cubic centimeters of vigorously boiling water and the cooking continued at the boiling point for ten minutes, when the temperature was allowed to fall to 85° C., and maintained at this temperature until the total time of cooking was equal to three hours. The cooked meat was well done and quite dry. The volume of the final broth measured 1,740 cubic centimeters.

The losses in weight during cooking were as follows:

Weight of meat before cooking .....	grams..	1,027.72
Weight of meat after cooking .....	do...	639.87
Loss in weight in cooking .....	do...	387.85
Loss in weight in cooking .....	per cent..	37.74

The detailed results of the experiment are shown in Tables 51 and 52.

TABLE 51.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 144.*

A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
ON FRESH BASIS.									
1764	Beef, round, uncooked .....	<i>Per ct.</i> 69.92	<i>Per ct.</i> 17.96	<i>Per ct.</i> 1.18	<i>Per ct.</i> 1.73	<i>Per ct.</i> 8.15	<i>Per ct.</i> 1.06	<i>Per ct.</i> 30.08	<i>Per ct.</i> 3.251
1768	Beef, round, cooked .....	58.81	31.19	.99	1.28	7.51	.89	41.86	5.309
1773	Broth (per cent uncooked meat) <sup>a</sup> .....		.20	.67	.73	.17	.46	2.23	.248
ON WATER-FREE BASIS.									
1764	Beef, round, uncooked .....		59.71	3.92	5.75	27.09	3.52	99.99	10.808
1768	Beef, round, cooked .....		75.72	2.40	3.11	18.23	2.16	101.62	12.889
1773	Broth (per cent uncooked meat) <sup>a</sup> .....		.67	2.24	2.44	.57	1.54	7.46	.823

B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1764	Beef, round, uncooked .....		2.70	1.18	1.73	0	0.73	6.34	0.811
1768	Beef, round, cooked .....		.21	.99	1.28	0	.32	2.80	.352
1773	Broth (per cent uncooked meat) <sup>a</sup> .....		.15	.67	.73	0	.46	2.01	.239
ON WATER-FREE BASIS.									
1764	Beef, round, uncooked .....		9.00	3.92	5.75	0	2.44	21.11	2.695
1768	Beef, round, cooked .....		.51	2.40	3.11	0	.79	6.81	.855
1773	Broth (per cent uncooked meat) <sup>a</sup> .....		.48	2.24	2.44	0	1.53	6.69	.794

C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1764	Beef, round, uncooked .....		15.26	0	0	8.15	0.33	23.74	2.440
1768	Beef, round, cooked .....		30.98	0	0	7.51	.57	39.06	4.957
1773	Broth (per cent uncooked meat) <sup>a</sup> .....		.05	0	0	.17	.....	.22	.009
ON WATER-FREE BASIS.									
1764	Beef, round, uncooked .....		50.71	0	0	27.09	1.08	78.88	8.113
1768	Beef, round, cooked .....		75.21	0	0	18.23	1.37	94.81	12.034
1773	Broth (per cent uncooked meat) <sup>a</sup> .....		.19	0	0	.57	.01	.77	.029

<sup>a</sup> Broth from cooked meat No. 1768.

TABLE 52.—*Results of cooking (boiling) experiment No. 144.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1768	In cooked meat .....	376.31	199.58	6.33	8.19	48.05	5.69
1773	In broth .....	364.83	2.07	6.91	7.54	1.75	4.75
1764	In uncooked meat .....	741.14	201.65	13.24	15.73	49.80	10.44
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1768	In cooked meat .....	50.77	98.97	47.81	52.06	96.48	54.50
1773	In broth .....	49.23	1.03	52.19	47.94	3.52	45.50
1773	In broth on basis of total weight of uncooked meat ...	35.50	.20	.67	.73	.17	.46

## COOKING EXPERIMENT No. 145.

In this experiment the beef round (sample No. 1769), in the form of 2-inch cubes, was plunged into 850 cubic centimeters of boiling water, the temperature of the water then reduced to 85° C. as quickly as possible, and the cooking continued at this temperature for three hours. The cooked meat was well done and quite dry. The volume of the final broth before dilution was 675 cubic centimeters.

The losses in weight during cooking were as follows:

Weight of meat before cooking.....	grams..	1,074.83
Weight of meat after cooking .....	do....	587.28
Loss in weight in cooking.....	do....	487.55
Loss in weight in cooking .....	per cent..	45.36

Tables 53 and 54 give the details of the experiment.

TABLE 53.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 145.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1764	Beef, round, uncooked .....	69.92	17.96	1.18	1.73	8.15	1.06	30.08	3.251
1769	Beef, round, cooked .....	56.49	34.41	.95	.88	6.87	.91	44.02	5.810
1772	Broth (per cent uncooked meat) <sup>a</sup> .....		.25	.75	.83	.44	.52	2.79	.280
	ON WATER-FREE BASIS.								
1764	Beef, round, uncooked .....		59.71	3.92	5.75	27.09	3.52	99.99	10.808
1769	Beef, round, cooked .....		79.09	2.18	2.02	15.79	2.09	101.17	13.353
1772	Broth (per cent uncooked meat) <sup>a</sup> .....		.82	2.50	2.77	1.45	1.73	9.27	.931

TABLE 53.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 145—Continued.*

## B. NUTRIENTS SOLUBLE IN COLD WATER.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
ON FRESH BASIS.									
1764	Beef, round, uncooked .....	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1769	Beef, round, cooked .....		2.70	1.18	1.73	0	0.73	6.34	0.811
1772	Broth (per cent uncooked meat) <sup>a</sup> .....		.21	.95	.88	0	.63	2.67	.339
			.17	.75	.83	0	.52	2.27	.267
ON WATER-FREE BASIS.									
1764	Beef, round, uncooked .....		9.00	3.92	5.75	0	2.44	21.11	2.695
1769	Beef, round, cooked .....		.50	2.18	2.02	0	1.46	6.16	.779
1772	Broth (per cent uncooked meat) <sup>a</sup> .....		.55	2.50	2.77	0	1.72	7.54	.888

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1764	Beef, round, uncooked .....		15.26	0	0	8.15	0.33	23.74	2.440
1769	Beef, round, cooked .....		34.20	0	0	6.87	.28	41.35	5.471
1772	Broth (per cent uncooked meat) <sup>a</sup> .....		.08	0	0	.44		.52	.013
ON WATER-FREE BASIS.									
1764	Beef, round, uncooked .....		50.71	0	0	27.09	1.08	78.88	8.113
1769	Beef, round, cooked .....		78.59	0	0	15.79	.63	95.01	12.574
1772	Broth (per cent uncooked meat) <sup>a</sup> .....		.27	0	0	1.45	.01	1.73	.043

<sup>a</sup> Broth from cooked meat No. 1769.TABLE 54.—*Results of cooking (boiling) experiment No. 145.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1769	In cooked meat.....	331.75	202.08	5.58	5.17	40.35	5.34
1772	In broth.....	457.59	2.64	8.07	8.96	4.70	5.59
1764	In uncooked meat.....	789.34	204.72	13.65	14.13	45.05	10.93
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
1769	In cooked meat.....	42.03	98.71	40.88	36.59	89.57	48.86
1772	In broth.....	57.97	1.29	59.12	63.41	10.43	51.14
1772	In broth on basis of total weight of uncooked meat....	42.57	.25	.75	.83	.44	.52

## COOKING EXPERIMENT NO. 146.

In this experiment lean beef round (sample No. 1770), cut about 5 inches thick and 4 inches across, was cooked as a pot roast. A small amount of beef fat (9.3 grams) was heated in a flat-bottomed kettle until "smoking hot," when the meat was added and well browned on all sides. A small quantity of water was then added from time to time and the cooking continued for three hours, the pot being kept closely covered. The cooked meat was well done and medium dry.



The losses in weight during cooking were as follows:

Weight of meat before cooking.....	grams..	966.87
Weight of meat after cooking.....	do....	545.08
Loss in weight in cooking.....	do....	421.79
Loss in weight in cooking.....	per cent..	43.62

The results of the experiment are given in detail in Tables 55 and 56.

TABLE 55.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 146.*

A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1764	Beef, round, uncooked.....	<i>Per ct.</i> 69.92	<i>Per ct.</i> 17.96	<i>Per ct.</i> 1.18	<i>Per ct.</i> 1.73	<i>Per ct.</i> 8.15	<i>Per ct.</i> 1.06	<i>Per ct.</i> 30.08	<i>Per ct.</i> 3.251
1770	Beef, round, cooked.....	51.95	34.53	1.40	1.69	9.66	1.21	48.49	5.972
	ON WATER-FREE BASIS.								
1764	Beef, round, uncooked.....		59.71	3.92	5.75	27.09	3.52	99.99	10.808
1770	Beef, round, cooked.....		71.86	2.91	3.52	20.10	2.52	100.91	12.429

B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1764	Beef, round, uncooked.....		2.70	1.18	1.73	0	0.73	6.34	0.811
1770	Beef, round, cooked.....		.31	1.40	1.69	0	.84	4.24	.498
ON WATER-FREE BASIS.									
1764	Beef, round, uncooked.....		9.00	3.92	5.75	0	2.44	21.11	2.695
1770	Beef, round, cooked.....		.65	2.91	3.52	0	1.75	8.83	1.036

C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1764	Beef, round, uncooked.....		15.26	0	0	8.15	0.33	.74	2.440
1770	Beef, round, cooked.....		34.22	0	0	9.66	.37	44.25	5.474
ON WATER-FREE BASIS.									
1764	Beef, round, uncooked.....		50.71	0	0	27.09	1.08	78.88	8.113
1770	Beef, round, cooked.....		71.21	0	0	20.10	.77	92.08	11.393

TABLE 56.—*Results of cooking (pot roast) experiment No. 146.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
1764	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1770	In uncooked meat.....	675.04	173.65	11.41	16.73	78.80	10.25
	In cooked meat.....	283.17	188.22	7.63	9.21	52.65	6.60
	Lost (—) or (apparently) gained (—).....	—392.87	+14.57	— 3.78	— 7.52	—26.15	— 3.65
1770	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
	In cooked meat.....	41.89	100.00	66.87	55.05	66.80	64.39
	Lost (—) or (apparently) gained (+).....	— 58.11	+ 8.39	—33.13	—44.95	—33.20	—35.61
	Lost (—) or (apparently) gained (+) in percentages of weight of uncooked meat.	— 40.63	+ 1.51	— .39	— .78	— 2.70	— .38

## COOKING EXPERIMENT No. 147.

In this experiment, the last of the series, the lean beef round (sample No. 1771), cut about 5 inches thick and 4 inches across, was roasted. The weighed meat was placed on the rack in a roasting pan and put in the oven of a gas stove. The temperature for the first fifteen minutes was 249° C. and for the remaining forty-five minutes 193° C. The cooked meat was well browned, medium underdone, or rare, and quite juicy. The quantity of drippings obtained was very small.

The losses in weight in cooking were as follows:

Weight of meat before cooking .....	grams..	1, 104. 40
Weight of meat after cooking .....	do....	920. 92
Loss in weight in cooking .....	do....	183. 48
Loss in weight in cooking .....	per cent..	16. 61

Tables 57 and 58 show the detailed results of the experiment.

TABLE 57.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 147.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
ON FRESH BASIS.									
1764	Beef, round, uncooked.....	Per ct. 69.92	Per ct. 17.96	Per ct. 1.18	Per ct. 1.73	Per ct. 8.15	Per ct. 1.06	Per ct. 30.08	Per ct. 3.251
1771	Beef, round, cooked .....	64.63	21.45	1.36	1.55	9.50	1.17	35.03	3.870
ON WATER-FREE BASIS.									
1764	Beef, round, uncooked.....		59.71	3.92	5.75	27.09	3.52	99.99	10.808
1771	Beef, round, cooked .....		60.64	3.84	4.38	26.86	3.31	99.03	10.941

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1764	Beef, round, uncooked.....	2.70	1.18	1.73	0	0.73	6.34	0.811	
1771	Beef, round, cooked .....	.75	1.36	1.55	0	.96	4.62	.557	
ON WATER-FREE BASIS.									
1764	Beef, round, uncooked.....	9.00	3.92	5.75	0	2.44	21.11	2.695	
1771	Beef, round, cooked .....	2.10	3.84	4.38	0	2.71	13.03	1.574	

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1764	Beef, round, uncooked.....	15.26	0	0	8.15	0.33	23.74	2.440	
1771	Beef, round, cooked .....	20.70	0	0	9.50	.21	30.41	3.313	
ON WATER-FREE BASIS.									
1764	Beef, round, uncooked.....	50.71	0	0	27.09	1.08	78.88	8.113	
1771	Beef, round, cooked .....	58.54	0	0	26.86	.60	86.00	9.367	

TABLE 58.—Results of cooking (roasting) experiment No. 147.

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1764	In uncooked meat.....	772.20	198.35	13.03	19.11	90.01	11.71
1771	In cooked meat.....	595.19	197.54	12.52	14.27	87.49	10.77
	Lost (—) or (apparently) gained (+).....	—177.01	— .81	— .51	— 4.84	—2.52	— .94
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1771	In cooked meat.....	77.08	99.59	96.09	74.67	97.20	91.97
	Lost (—) or (apparently) gained (+).....	— 22.92	— .41	—3.91	—25.33	—2.80	—8.03
	Lost (—) or (apparently) gained (+) in percentages of weight of uncooked meat ...	— 16.03	— .07	— .05	— .44	— .23	— .09

## SERIES X.—EXPERIMENTS NOS. 150–156.

The object of this series of seven experiments was similar to that of Series IX, namely, to determine the influence of the different methods of cooking (1) upon the soluble and the insoluble constituents of meat and (2) upon the character and amounts of the losses of nutrients. The lean beef round selected was freed from all bone, gristle, and most of the visible fat and divided as follows: (1) A representative cross-section cut, about 0.5 inch thick (sample No. 1775), was reserved for analysis; (2) three steaks, 1 inch thick, of approximately equal size and as near alike as possible in appearance and composition, were cut for use in experiments Nos. 150, 151, and 152; (3) three pieces, about 5 inches thick and 4 inches across, as near alike in appearance, shape, and size as possible, were cut for experiments Nos. 153, 155, and 156; and (4) one portion was cut into pieces about 2 inches square for experiment No. 154.

## COOKING EXPERIMENT No. 150.

One of the steaks (No. 1776) 1 inch in thickness was sautéed. A small amount (12 grams) of beef fat was heated in a frying pan until it began to smoke. The meat was then added and cooked for twenty minutes, with frequent turning. When done it was well browned, underdone, or rare, and juicy.

The losses in weight during cooking were as follows:

Weight of meat before cooking .....	grams..	641.09
Weight of meat after cooking .....	do....	549.85
Loss in weight in cooking .....	do....	91.24
Loss in weight in cooking .....	per cent..	14.23

The details of the experiment are shown in Tables 59 and 60.

TABLE 59.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 150.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1775	Beef, round, uncooked.....	<i>Per ct.</i> 73.28	<i>Per ct.</i> 18.67	<i>Per ct.</i> 1.13	<i>Per ct.</i> 1.40	<i>Per ct.</i> 4.91	<i>Per ct.</i> 1.09	<i>Per ct.</i> 27.20	<i>Per ct.</i> 3.349
1776	Beef, round, cooked.....	66.66	22.77	1.37	1.61	6.34	1.17	33.26	4.083
	ON WATER-FREE BASIS.								
1775	Beef, round, uncooked.....		69.87	4.23	5.24	18.38	4.08	101.80	12.534
1776	Beef, round, cooked.....		68.30	4.11	4.83	19.02	3.51	99.77	12.246

## B. NUTRIENTS SOLUBLE IN COLD WATER.

	ON FRESH BASIS.								
1775	Beef, round, uncooked.....		2.20	1.13	1.40	0	0.87	5.60	0.714
1776	Beef, round, cooked.....		.73	1.37	1.61	0	.95	4.66	.556
	ON WATER-FREE BASIS.								
1775	Beef, round, uncooked.....		8.23	4.23	5.24	0	3.26	20.96	2.673
1776	Beef, round, cooked.....		2.19	4.11	4.83	0	2.85	13.98	1.667

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

	ON FRESH BASIS.								
1775	Beef, round, uncooked.....		16.47	0	0	4.91	0.22	21.60	2.635
1776	Beef, round, cooked.....		22.04	0	0	6.34	.22	28.60	3.527
	ON WATER-FREE BASIS.								
1775	Beef, round, uncooked.....		61.64	0	0	18.38	.82	80.84	9.861
1776	Beef, round, cooked.....		66.11	0	0	19.02	.66	85.79	10.579

TABLE 60.—*Results of cooking (sautéeing) experiment No. 150.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extrac- tives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
1775	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1776	In uncooked meat.....	469.79	119.69	7.24	8.98	31.48	6.99
	In cooked meat.....	366.53	125.20	7.53	8.85	34.86	6.43
	Lost (—) or (apparently) gained (+).....	—103.26	+5.51	+ .29	— .13	+ 3.38	— .56
1776	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
	In cooked meat.....	78.02	100.00	100.00	98.55	100.00	91.99
	Lost (—) or (apparently) gained (+).....	— 21.98	+4.60	+4.01	—1.45	+10.74	—8.01
	Lost (—) or (apparently) gained (+) in percentage of weight of uncooked meat ...	— 16.11	+ .86	+ .05	— .02	+ .53	— .09

## COOKING EXPERIMENT No. 151.

One of the steaks (sample No. 1777) 1 inch in thickness was pan-broiled as follows: The pan was heated until "blue hot" and the meat was then put in it and cooked for ten minutes with frequent turning, no fat being added either before or during the cooking. The cooked meat was well browned, decidedly underdone, or rare, and juicy.

The losses in weight during cooking were as follows:

Weight of meat before cooking.....	grams..	664.60
Weight of meat after cooking .....	do....	536.05
Loss in weight in cooking.....	do....	128.55
Loss in weight in cooking .....	per cent..	19.34

Tables 61 and 62 give the details of the experiment.

TABLE 61.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 151.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1775	Beef, round, uncooked.....	<i>Per ct.</i> 73.28	<i>Per ct.</i> 18.67	<i>Per ct.</i> 1.13	<i>Per ct.</i> 1.40	<i>Per ct.</i> 4.91	<i>Per ct.</i> 1.09	<i>Per ct.</i> 27.20	<i>Per ct.</i> 3.349
1777	Beef, round, cooked .....	65.74	24.74	1.48	1.72	5.83	1.24	35.01	4.435
	ON WATER-FREE BASIS.								
1775	Beef, round, uncooked.....		69.87	4.23	5.24	18.38	4.08	101.80	12.534
1777	Beef, round, cooked .....		72.21	4.32	5.02	17.02	3.62	102.19	12.945

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1775	Beef, round, uncooked.....		2.20	1.13	1.40	0	0.87	5.60	0.714
1777	Beef, round, cooked .....		.58	1.48	1.72	0	1.05	4.83	.569
ON WATER-FREE BASIS.									
1775	Beef, round, uncooked.....		8.23	4.23	5.24	0	3.26	20.96	2.673
1777	Beef, round, cooked .....		1.69	4.32	5.02	0	3.07	14.10	1.661

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1775	Beef, round, uncooked.....		16.47	0	0	4.91	0.22	21.60	2.635
1777	Beef, round, cooked .....		24.16	0	0	5.83	.19	30.18	3.866
ON WATER-FREE BASIS.									
1775	Beef, round, uncooked.....		61.64	0	0	18.38	.82	80.84	9.861
1777	Beef, round, cooked .....		70.52	0	0	17.02	.55	88.09	11.284

TABLE 62.—Results of cooking (pan broiling) experiment No. 151.

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
1775	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1777	In uncooked meat.....	487.02	124.08	7.51	9.30	32.63	7.24
	In cooked meat.....	352.40	132.62	7.93	9.22	31.25	6.65
	Lost (—) or (apparently) gained (+).....	—134.62	+8.54	+ .42	— .08	—1.38	— .59
1777	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
	In cooked meat.....	72.36	100.00	100.00	99.14	95.77	91.85
	Lost (—) or (apparently) gained (+).....	—27.64	+6.88	+5.59	— .86	—4.23	—8.15
	Lost (—) or (apparently) gained (+) in percentages of weight of uncooked meat...	—20.26	+1.29	+ .06	— .01	— .21	— .09

## COOKING EXPERIMENT No. 152.

The third 1-inch steak (sample No. 1778) was cooked by "gas broiling," that is, broiling over a gas flame, for ten minutes, this method of cooking being substituted for frying in deep fat, the method used in the former series of experiments (experiment No. 143), to which the present series corresponds. The cooked meat was well browned, decidedly underdone, or rare, and juicy.

The losses in weight in cooking were as follows:

Weight of meat before cooking.....	grams..	662.97
Weight of meat after cooking.....	do....	551.95
Loss in weight in cooking.....	do....	111.02
Loss in weight in cooking.....	per cent..	16.75

Tables 63 and 64 give the details of the experiment.

TABLE 63.—Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 152.

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1775	Beef, round, uncooked .....	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1778	Beef, round, cooked.....	73.28	18.67	1.13	1.40	4.91	1.09	27.20	3.349
		66.26	22.78	1.38	1.62	7.64	1.22	34.64	4.088
	ON WATER-FREE BASIS.								
1775	Beef, round, uncooked.....		69.87	4.23	5.24	18.38	4.08	101.80	12.534
1778	Beef, round, cooked.....		67.52	4.09	4.80	22.64	3.61	102.66	12.116



TABLE 63.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 152—Continued.*

## B. NUTRIENTS SOLUBLE IN COLD WATER.

Laboratory No.	Kind of material.	Water.	Pro. teid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitro- gen.
				Nitrog- enous.	Non- nitrog- enous.				
ON FRESH BASIS.									
1775	Beef, round, uncooked.....	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1778	Beef, round, cooked.....								
ON WATER-FREE BASIS.									
1775	Beef, round, uncooked.....								
1778	Beef, round, cooked.....								

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1775	Beef, round, uncooked.....								
1778	Beef, round, cooked.....								
ON WATER-FREE BASIS.									
1775	Beef, round, uncooked.....								
1778	Beef, round, cooked.....								

TABLE 64.—*Results of cooking (gas broiling) experiment No. 152.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
1775	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1778	In uncooked meat.....	485.82	123.78	7.49	9.28	32.55	7.23
	In cooked meat.....	365.72	125.73	7.62	8.94	42.17	6.73
	Lost (—) or (apparently) gained (+).....	—120.10	+1.95	+ .13	— .34	+ 9.62	— .50
1778	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
	In cooked meat.....	75.28	100.00	100.00	96.34	100.00	93.08
	Lost (—) or (apparently) gained (+).....	—24.72	+1.58	+1.74	—3.66	+29.55	—6.92
	Lost (—) or (apparently) gained (+) in percentages of weight of uncooked meat...	—18.12	+ .29	+ .02	— .05	+ 1.45	— .08

## COOKING EXPERIMENT NO. 153.

One of the pieces of the beef round (sample No. 1779), about 5 inches thick and 4 inches across, was cooked by plunging it into 2,000 cubic centimeters of vigorously boiling water. This temperature was maintained for ten minutes, and then allowed to fall to 85° C. and kept at this point. The total time of cooking was three hours. The cooked meat was well done and quite dry.

The losses in weight in cooking were as follows:

Weight of meat before cooking .....	grams..	1,098.31
Weight of meat after cooking .....	do....	607.44
Loss in weight in cooking .....	do....	490.87
Loss in weight in cooking .....	per cent..	44.69

The details of the experiment are given in Tables 65 and 66.

TABLE 65.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 153.*

A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
ON FRESH BASIS.									
1775	Beef, round, uncooked.....	<i>Per ct.</i> 73.28	<i>Per ct.</i> 18.67	<i>Per ct.</i> 1.13	<i>Per ct.</i> 1.40	<i>Per ct.</i> 4.91	<i>Per ct.</i> 1.09	<i>Per ct.</i> 27.20	<i>Per ct.</i> 3.349
1779	Beef, round, cooked.....	54.17	35.71	.94	1.04	7.88	.84	46.41	6.013
1784	Broth (per cent uncooked meat) <sup>a</sup> .....		.19	.73	.87	.38	.52	2.69	.295
ON WATER-FREE BASIS.									
1775	Beef, round, uncooked.....		69.87	4.23	5.24	18.38	4.08	101.80	12.534
1779	Beef, round, cooked.....		77.92	2.05	2.27	17.19	1.83	101.26	13.120
1784	Broth (per cent uncooked meat) <sup>a</sup> .....		.69	2.75	3.27	1.56	1.93	10.20	.992

B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1775	Beef, round, uncooked . . . . .	2.20	1.13	1.40	0	0.87	5.60	0.714	
1779	Beef, round, cooked . . . . .	.20	.94	1.04	0	.60	2.78	.332	
1784	Broth (per cent uncooked meat) <sup>a</sup> . . . . .	.16	.73	.87	0	.52	2.28	.261	
ON WATER-FREE BASIS.									
1775	Beef, round, uncooked . . . . .	8.23	4.23	5.24	0	3.26	20.96	2.673	
1779	Beef, round, cooked . . . . .	.44	2.05	2.27	0	1.31	6.07	.724	
1784	Broth (per cent uncooked meat) <sup>a</sup> . . . . .	.61	2.75	3.27	0	1.93	8.56	.978	

C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.								
1775	Beef, round, uncooked.....	16.47	0	0	4.91	0.22	21.60	2.635
1779	Beef, round, cooked.....	35.51	0	0	7.88	.24	43.63	5.681
1784	Broth (per cent uncooked meat) <sup>a</sup> .....	.03	0	0	.38	.....	.41	.034
ON WATER-FREE BASIS.								
1775	Beef, round, uncooked.....	61.64	0	0	18.38	.82	80.84	9.861
1779	Beef, round, cooked.....	77.48	0	0	17.19	.52	95.19	12.396
1784	Broth (per cent uncooked meat) <sup>a</sup> .....	.08	0	0	1.56	.....	1.64	.014

<sup>a</sup> Broth from sample No. 1779.

TABLE 66.—*Results of cooking (boiling) experiment No. 153.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1779	In cooked meat.....	329.05	216.92	5.71	6.32	47.87	5.10
1784	In broth <sup>a</sup> .....	461.32	2.03	8.07	9.60	4.18	5.67
1775	In uncooked meat.....	790.37	218.95	13.78	15.92	52.05	10.77
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
1779	In cooked meat.....	41.63	99.07	41.44	39.70	91.97	47.35
1784	In broth <sup>a</sup> .....	58.37	.93	58.56	60.30	8.03	52.65
1784	In broth on basis of total weight of uncooked meat <sup>a</sup> ..	42.00	.19	.73	.87	.38	.52

<sup>a</sup> Broth from sample No. 1779.

## COOKING EXPERIMENT No. 154.

In this experiment, which is a duplicate of No. 145, the beef round cut into 2-inch cubes (sample No. 1780) was put into 850 cubic centimeters of boiling water. The temperature of the water was then allowed to drop to 85° C. and so maintained, the duration of the entire cooking period being three hours. The cooked meat was well done and dry.

The losses in weight during cooking were as follows:

Weight of meat before cooking.....	grams..	1,052.17
Weight of meat after cooking.....	do....	554.29
Loss in weight in cooking.....	do....	497.88
Loss in weight in cooking.....	per cent..	47.32

Tables 67 and 68 show the details of the experiment.

TABLE 67.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 154.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1775	Beef, round, uncooked.....	73.28	18.67	1.13	1.40	4.91	1.09	27.20	3.349
1780	Beef, round, cooked.....	55.19	36.15	.80	.92	6.62	.85	45.34	6.040
1783	Broth (per cent uncooked meat) <sup>a</sup> .....		.25	.73	.90		.53		.274
	ON WATER-FREE BASIS.								
1775	Beef, round, uncooked.....		69.87	4.23	5.24	18.38	4.08	101.80	12.534
1780	Beef, round, cooked.....		80.67	1.79	2.05	14.77	1.87	101.15	13.479
1783	Broth (per cent uncooked meat) <sup>a</sup> .....		.93	2.74	3.35		1.97		1.027

TABLE 67.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 154—Continued.*

## B. NUTRIENTS SOLUBLE IN COLD WATER.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
ON FRESH BASIS.									
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1775	Beef, round, uncooked.....		2.20	1.13	1.40	0	0.87	5.60	0.714
1780	Beef, round, cooked.....		.13	.80	.92	0	.57	2.42	.276
1783	Broth (per cent uncooked meat) <sup>a</sup> .....		.12	.70	.90	0	.53	2.28	.255
ON WATER-FREE BASIS.									
1775	Beef, round, uncooked.....		8.23	4.23	5.24	0	3.26	20.96	2.673
1780	Beef, round, cooked.....		.29	1.79	2.05	0	1.27	5.40	.616
1783	Broth (per cent uncooked meat) <sup>a</sup> .....		.47	2.74	3.35	0	1.96	8.52	.953

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1775	Beef, round, uncooked.....	14.47	0	0	4.91	0.22	21.60	2.635	
1780	Beef, round, cooked.....	30.02	0	0	6.62	.28	42.92	5.764	
1783	Broth (per cent uncooked meat) <sup>a</sup> .....	.13	0	0				.019	
ON WATER-FREE BASIS.									
1775	Beef, round, uncooked.....	61.64	0	0	18.38	.82	80.84	9.861	
1780	Beef, round, cooked.....	80.88	0	0	14.77	.60	95.75	12.863	
1783	Broth (per cent uncooked meat) <sup>a</sup> .....	.46	0	0				.074	

<sup>a</sup> Broth from sample No. 1780.TABLE 68.—*Results of cooking (boiling) experiment No. 154.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1780	In cooked meat .....	305.91	200.38	4.43	5.10	36.69	4.71
1783	In broth.....		2.62	7.70	9.42		5.53
1775	In uncooked meat.....		203.00	12.13	14.52		10.24
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
1780	In cooked meat .....		98.71	36.52	35.12		46.00
1783	In broth.....		1.29	63.48	64.88		54.00
1783	In broth on basis of total weight of uncooked meat .....		.25	.73	.90		.53

<sup>a</sup> Broth from sample No. 1780.

## COOKING EXPERIMENT No. 155.

The second piece of lean beef round (sample No. 1781), cut about 5 inches thick and 4 inches across, was cooked as a pot roast. A small quantity of beef fat (9 grams) was heated in a flat-bottomed kettle until "smoking" hot, the meat added, and well browned on all sides. A small quantity of water was added from time to time and the cooking continued for three hours, the pot being kept closely covered. The cooked meat was well done and medium dry.

The losses in weight during cooking were as follows:

Weight of meat before cooking.....	grams..	1, 041. 33
Weight of meat after cooking .....	do....	558. 56
Loss in weight in cooking.....	do....	482. 77
Loss in weight in cooking.....	per cent..	46. 36

Tables 69 and 70 show the details of the experiment.

TABLE 69.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 155.*

A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1775	Beef, round, uncooked.....	Per ct. 73.28	Per ct. 18.67	Per ct. 1.13	Per ct. 1.40	Per ct. 4.91	Per ct. 1.09	Per ct. 27.20	Per ct. 3.349
1781	Beef, round, cooked.....	52.96	34.61	1.11	1.17	9.87	1.10	47.86	5.891
	ON WATER-FREE BASIS.								
1775	Beef, round, uncooked.....		69.87	4.23	5.24	18.38	4.08	101.80	12.534
1781	Beef, round, cooked.....		73.57	2.36	2.49	20.98	2.33	101.73	12.523

B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.								
1775	Beef, round, uncooked.....	2.20	1.13	1.40	0	0.87	5.60	0.714
1781	Beef, round, cooked.....	.42	1.11	1.17	0	.83	3.53	.421
ON WATER-FREE BASIS.								
1775	Beef, round, uncooked.....	8.23	4.23	5.24	0	3.26	20.96	2.673
1781	Beef, round, cooked.....	.89	2.36	2.49	0	1.76	7.50	.895

C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.								
1775	Beef, round, uncooked.....	16.47	0	0	4.91	0.22	21.60	2.635
1781	Beef, round, cooked.....	34.19	0	0	9.87	.27	44.33	5.470
ON WATER-FREE BASIS.								
1775	Beef, round, uncooked.....	61.64	0	0	18.38	.82	80.84	9.861
1781	Beef, round, cooked.....	72.68	0	0	20.98	.57	94.23	11.628

TABLE 70.—*Results of cooking (pot roasting) experiment No. 155.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
1775	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1781	In uncooked meat.....	763.08	194.42	11.77	14.58	51.12	11.35
	In cooked meat.....	295.81	193.32	6.20	6.54	55.13	6.14
	Loss (—) or (apparent) gain (+) <sup>a</sup> .....	—467.27	—1.10	—5.57	—8.04	—4.01	—5.21
1781	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
	In cooked meat.....	38.77	99.43	52.67	44.86	100.00	54.10
	Loss (—) or (apparent) gain (+) <sup>a</sup> .....	—61.23	— .57	—47.33	—55.14	+7.84	—45.90
	Loss (—) or (apparent) gain (+) in percentages of weight of uncooked meat <sup>a</sup> .....	—44.87	— .11	— .54	— .77	+ .39	— .49

<sup>a</sup> See U. S. Dept. Agr., Office of Experiment Stations Bul. 141, p. 62 et seq.

The third piece of the lean beef round (sample No. 1782), cut about 5 inches thick and 4 inches across, was cooked by roasting in the oven of a gas stove, the weighed meat being placed on the rack of a roasting pan. The temperature of the oven for the first fifteen minutes was 249° C. and for the remaining forty minutes of the cooking period 193° C. The cooked meat was well browned, decidedly underdone, or rare, and juicy.

The losses in weight in cooking were as follows:

Weight of meat before cooking .....	grams..	1, 110. 88
Weight of meat after cooking .....	do....	935. 49
Loss in weight in cooking.....	do....	175. 39
Loss in weight in cooking .....	per cent..	15. 79

The details of the experiment are shown in Tables 71 and 72.

TABLE 71.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 156.*

A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
ON FRESH BASIS.									
1775	Beef, round, uncooked .....	<i>Per ct.</i> 73. 28	<i>Per ct.</i> 18. 67	<i>Per ct.</i> 1. 13	<i>Per ct.</i> 1. 40	<i>Per ct.</i> 4. 91	<i>Per ct.</i> 1. 09	<i>Per ct.</i> 27. 20	<i>Per ct.</i> 3. 349
1782	Beef, round, cooked.....	68. 58	23. 19	. 94	1. 27	5. 42	1. 16	31. 98	4. 011
ON WATER-FREE BASIS.									
1775	Beef, round, uncooked .....		69. 87	4. 23	5. 24	18. 38	4. 08	101. 80	12. 534
1782	Beef, round, cooked.....		73. 80	2. 99	4. 04	17. 25	3. 69	101. 77	12. 766

B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1775	Beef, round, uncooked .....		2. 20	1. 13	1. 40	0	0. 87	5. 60	0. 714
1782	Beef, round, cooked.....		1. 23	. 94	1. 27	0	. 95	4. 39	. 497
ON WATER-FREE BASIS.									
1775	Beef, round, uncooked .....		8. 23	4. 23	5. 24	0	3. 26	20. 96	2. 673
1782	Beef, round, cooked.....		3. 91	2. 99	4. 04	0	3. 02	13. 96	1. 582

C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1775	Beef, round, uncooked .....		16. 47	0	0	4. 91	0. 22	21. 60	2. 635
1782	Beef, round, cooked.....		21. 96	0	0	5. 42	. 21	27. 59	3. 514
ON WATER-FREE BASIS.									
1775	Beef, round, uncooked .....		61. 64	0	0	18. 38	. 82	80. 84	9. 861
1782	Beef, round, cooked.....		69. 89	0	0	17. 25	. 67	87. 81	11. 184



TABLE 72.—*Results of cooking (roasting) experiment No. 156.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1775	In uncooked meat .....	814.05	207.40	12.55	15.55	54.54	12.11
1782	In cooked meat .....	641.56	216.94	8.79	11.88	50.70	10.85
	Loss (-) or (apparent) gain (+) <i>a</i> .....	-172.49	+ 9.54	- 3.76	- 3.67	- 3.84	- 1.26
	Proportion of nutrients:	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1782	In cooked meat .....	78.81	100.00	70.04	76.40	92.96	89.60
	Loss (-) or (apparent) gain (+) <i>a</i> .....	- 21.19	- 4.60	-29.96	-23.60	- 7.04	-10.40
	Loss (-) or (apparent) gain (+) in percentages of weight of uncooked meat <i>a</i> ..	- 15.53	+ .86	- .34	- .33	- .35	- .11

*a*See U. S. Dept. Agr., Office of Experiment Stations Bulletin 41, p. 62 et seq.

## MEATS COOKED BY DRY HEAT AND THEN BY BOILING.

### SERIES XI.—EXPERIMENTS NOS. 133-136.

The chief object of this series of four experiments was to discover what influence the previous browning of meat has (1) upon the nature and quantity of the losses, and (2) upon the character of the resulting cooked meats. Lean beef round from which all bone, gristle, and lumps of visible fat had been removed was used in all the tests. The entire cut was divided into 2-inch cubes, and after thorough mixing was separated into five portions—four (Nos. 1743, 1744, 1745, and 1746) for cooking, and one (No. 1741) for complete chemical analysis.

#### COOKING EXPERIMENT No. 133.

Sample No. 1743 was used for the first experiment, and was cooked by placing it first in 2,000 cubic centimeters of boiling water and then cooking at this temperature for three hours.

The losses in weights were as follows:

Weight of meat before cooking .....	grams..	1,000.00
Weight of meat after cooking .....	do....	548.22
Loss in weight in cooking .....	do....	451.78
Loss in weight in cooking .....	per cent..	45.18

The details of the experiment are given in Tables 73 and 74.

TABLE 73.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 133.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
ON FRESH BASIS.									
1741	Beef, round, uncooked.....	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1743	Beef, round, cooked.....	72.46	18.91	1.24	1.78	4.52	1.06	27.51	3.424
1743	Broth (percent uncooked meat) .....	57.65	34.92	.77	1.04	5.06	.74	42.53	5.894
			.39	.89	1.11	.46	.62	3.47	.347
ON WATER-FREE BASIS.									
1741	Beef, round, uncooked.....		68.66	4.50	6.46	16.41	3.85	99.88	12.433
1743	Beef, round, cooked.....		82.45	1.82	2.46	11.95	1.75	100.43	13.776
1743	Broth (percent uncooked meat) .....		1.43	3.22	4.03	1.66	2.26	12.60	1.262

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1741	Beef, round, uncooked.....		2.80	1.24	1.78	0	0.89	6.71	0.846
1748	Beef, round, cooked <i>a</i> .....		.33	.77	1.04	0	.57	2.71	.300
1743	Broth (percent uncooked meat).....		.35	.89	1.11	0	.62	2.97	.340
ON WATER-FREE BASIS.									
1741	Beef, round, uncooked.....		10.15	4.50	6.46	0	3.23	24.34	3.071
1748	Beef, round, cooked <i>a</i> .....		.78	1.82	2.46	0	1.35	6.41	.707
1743	Broth (percent uncooked meat).....		1.27	3.22	4.03	0	2.25	10.77	1.236

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1741	Beef, round, uncooked.....		16.11	0	0	4.52	0.17	20.80	2.578
1748	Beef, round, cooked <i>a</i> .....		34.59	0	0	5.06	.17	39.82	5.534
1743	Broth (percent uncooked meat).....		.04	0	0	.46	.....	.50	.007
ON WATER-FREE BASIS.									
1741	Beef, round, uncooked.....		58.51	0	0	16.41	.62	75.54	9.362
1748	Beef, round, cooked <i>a</i> .....		81.67	0	0	11.95	.40	94.02	13.069
1743	Broth (percent uncooked meat).....		.16	0	0	1.66	.01	1.83	.026

*a* Cooked meat from sample No. 1743.TABLE 74.—*Results of cooking (boiling) experiment No. 133.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1743	In cooked meat .....	316.05	191.44	4.22	5.70	27.74	4.06
1743	In broth .....	417.08	3.94	8.87	11.10	4.57	6.22
1741	In uncooked meat.....	733.13	195.38	13.09	16.80	32.31	10.28
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1743	In cooked meat.....	43.11	97.98	32.24	33.93	85.86	39.49
1743	In broth .....	56.89	2.02	67.76	66.07	14.14	60.51
1743	In broth on basis of total weight of uncooked meat...	41.71	.39	.89	1.11	.46	.62

## COOKING EXPERIMENT NO. 134.

The second portion of beef round (sample No. 1744) was plunged into boiling water and the temperature of the water maintained as near the boiling point as possible for ten minutes. It was then allowed to drop to 85° C. and the cooking continued at this temperature until the total period covered three hours.

The losses in weight in cooking were as follows:

Weight of meat before cooking .....	grams..	1,000.00
Weight of meat after cooking .....	do....	543.07
Loss in weight in cooking.....	do....	456.93
Loss in weight in cooking.....	per cent..	45.69

Tables 75 and 76 record the details of the experiment.

TABLE 75.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No 134.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.								
1741	Beef, round, uncooked .....	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1744	Beef, round, cooked .....	72.46	18.91	1.21	1.78	4.52	1.06	27.51	3.424
1744	Broth (percent uncooked meat) .....	57.88	35.05	.79	1.08	4.83	.73	42.48	5.862
			.33	.87	1.19	.31	.61	3.31	.331
	ON WATER-FREE BASIS.								
1741	Beef, round, uncooked .....		68.66	4.50	6.46	16.41	3.85	99.88	12.433
1744	Beef, round, cooked .....		83.21	1.88	2.56	11.47	1.73	100.85	13.917
1744	Broth (percent uncooked meat) .....		1.21	3.15	4.31	1.14	2.23	12.04	1.203

## B. NUTRIENTS SOLUBLE IN COLD WATER.

	ON FRESH BASIS.								
1741	Beef, round, uncooked .....		2.80	1.24	1.78	0	0.89	6.71	0.846
1749	Beef, round, cooked <sup>a</sup> .....		.33	.79	1.08	0	.53	2.73	.307
1744	Broth (percent uncooked meat) .....		.28	.87	1.19	0	.61	2.95	.322
	ON WATER-FREE BASIS.								
1741	Beef, round, uncooked .....		10.15	4.50	6.46	0	3.23	24.34	3.071
1749	Beef, round, cooked <sup>a</sup> .....		.78	1.88	2.56	0	1.26	6.48	.728
1744	Broth (percent uncooked meat) .....		1.00	3.15	4.31	0	2.22	10.68	1.171

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

	ON FRESH BASIS.								
1741	Beef, round, uncooked .....		16.11	0	0	4.52	0.17	20.80	2.578
1749	Beef, round, cooked <sup>a</sup> .....		34.72	0	0	4.83	.20	39.75	5.555
1744	Broth (percent uncooked meat) .....		.05	0	0	.31		.36	.009
	ON WATER-FREE BASIS.								
1741	Beef, round, uncooked .....		58.51	0	0	16.41	.62	75.54	9.362
1749	Beef, round, cooked <sup>a</sup> .....		82.43	0	0	11.47	.47	94.37	13.189
1744	Broth (percent uncooked meat) .....		.21	0	0	1.14	.01	1.36	.032

<sup>a</sup> Cooked meat from sample No. 1744.

TABLE 76.—*Results of cooking (boiling) experiment No. 134.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1744	In cooked meat.....	314.33	190.35	4.29	5.87	26.23	3.96
1744	In broth.....	423.80	3.32	8.68	11.86	3.13	6.14
1741	In uncooked meat.....	738.13	193.67	12.97	17.73	29.36	10.10
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
1744	In cooked meat.....	42.58	98.29	33.08	33.11	89.34	39.21
1744	In broth.....	57.42	1.71	66.92	66.89	10.66	60.79
1744	In broth on basis of total weight of uncooked meat...	42.38	.33	.87	1.19	.31	.61

## COOKING EXPERIMENT NO. 135.

The third 1,000-gram portion (sample No. 1745) of the beef round, cut into 2-inch cubes, was first browned or sautéed in 26.3 grams of beef fat for fifteen minutes, and then while still hot was transferred to 2,000 cubic centimeters of boiling distilled water, part of which was first used to rinse out the frying pan. The pan was further cleaned by scraping with a spatula, and all material removed was added to the meat. The cooking was continued at the temperature of boiling water until the total time equaled three hours.

The losses in weight in cooking were as follows:

Weight of meat before cooking .....	grams..	1,000.00
Weight of meat after cooking .....	do.....	560.68
Loss in weight in cooking.....	do.....	439.32
Loss in weight in cooking .....	per cent..	43.93

The detailed results of the experiment are shown in tables 77 and 78.

TABLE 77.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 135.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
ON FRESH BASIS.									
1741	Beef, round, uncooked.....	72.46	18.91	1.24	1.78	4.52	1.06	27.51	3.424
1745	Beef, round, cooked .....	57.19	33.28	.72	.79	7.74	.73	43.26	5.556
1745	Broth (percent uncooked meat) .....		.43	.82	1.07	2.48	.57	5.37	.331
ON WATER-FREE BASIS.									
1741	Beef, round, uncooked.....		68.66	4.50	6.46	16.41	3.85	99.88	12.433
1745	Beef, round, cooked .....		77.74	1.68	1.85	18.08	1.70	101.05	12.978
1745	Broth (percent uncooked meat) .....		1.56	2.98	3.87	9.00	2.07	19.48	1.203

TABLE 77.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 135—Continued.*

## B. NUTRIENTS SOLUBLE IN COLD WATER.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1741	Beef, round, uncooked.....		2.80	1.24	1.78	0	0.89	6.71	0.846
1750	Beef, round, cooked <sup>a</sup> .....		.24	.72	.79	0	.51	2.26	.270
1745	Broth (percent uncooked meat).....		.33	.82	1.07	0	.57	2.79	.316
	ON WATER-FREE BASIS.								
1741	Beef, round, uncooked.....		10.15	4.50	6.46	0	3.23	24.34	3.071
1750	Beef, round, cooked <sup>a</sup> .....		.57	1.68	1.85	0	1.19	5.29	.631
1745	Broth (percent uncooked meat).....		1.20	2.98	3.87	0	2.06	10.11	1.146

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1741	Beef, round, uncooked.....	16.11	0	0	4.52	0.17	20.80	2.578	
1750	Beef, round, cooked <sup>a</sup> .....	33.04	0	0	7.74	.22	41.00	5.286	
1745	Broth (percent uncooked meat).....	.10	0	0	2.48	.....	2.58	.015	
ON WATER-FREE BASIS.									
1741	Beef, round, uncooked.....	58.51	0	0	16.41	.62	75.54	9.362	
1750	Beef, round, cooked <sup>a</sup> .....	77.17	0	0	18.08	.51	95.76	12.347	
1745	Broth (percent uncooked meat).....	.36	0	0	9.00	.01	9.37	.057	

<sup>a</sup> Cooked meat from sample No. 1745.TABLE 78.—*Results of cooking (browned in fat, then boiled) experiment No 135.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1745	In cooked meat .....	320.65	186.59	4.04	4.43	43.40	4.09
1745	In broth .....	385.69	1.29	8.19	10.66	24.79	5.70
1741	In uncooked meat .....	706.34	190.88	12.23	15.09	68.19	9.79
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1745	In cooked meat .....	45.40	97.75	33.03	29.36	63.65	41.78
1745	In broth .....	54.60	2.25	66.97	70.64	36.35	58.22
1745	In broth on basis of total weight of uncooked meat...	38.57	.43	.82	1.07	2.48	.57

## COOKING EXPERIMENT No. 136.

The fourth 1,000-gram portion of beef round (sample No. 1746), in the form of 2-inch cubes, was first browned or sautéed in 21 grams of beef fat for fifteen minutes, and while still hot was transferred to 2,000 cubic centimeters of boiling distilled water. The same precautions were used as in the preceding experiment to transfer the sautéed meat without loss from the frying pan to the vessel in which it was boiled. The meat was further cooked by maintaining the temperature of the water as near the boiling point as possible for ten minutes and

then allowing it to drop to 85° C., keeping it at this point until the total time of cooking equaled three hours.

The losses in weight during cooking were as follows:

Weight of meat before cooking.....	grams..	1,000.00
Weight of meat after cooking .....	do....	557.76
Loss in weight in cooking.....	do....	442.24
Loss in weight in cooking .....	per cent..	44.22

Tables 79 and 80 give the details of the experiment.

TABLE 79.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 136.*

A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
ON FRESH BASIS.									
1741	Beef, round, uncooked .....	72.46	18.91	1.24	1.78	4.52	1.06	27.51	3.424
1746	Beef, round, cooked .....	56.50	34.13	.73	.91	7.12	.70	43.59	5.696
1746	Broth percent uncooked meat .....		.35	.84	1.10	1.62	.61	4.52	.323
ON WATER-FREE BASIS.									
1741	Beef, round, uncooked .....		68.66	4.50	6.46	16.41	3.85	99.88	12.453
1746	Beef, round, cooked .....		78.46	1.68	2.09	16.37	1.61	100.21	13.094
1746	Broth percent uncooked meat .....		1.25	3.03	3.98	5.88	2.20	16.34	1.172

B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.								
1741	Beef, round, uncooked.....	2.80	1.24	1.78	0	0.89	6.71	0.846
1751	Beef, round, cooked.....	.15	.73	.91	0	.51	2.30	.260
1746	Broth percent uncooked meat.....	.21	.84	1.10	0	.61	2.76	.202
ON WATER-FREE BASIS.								
1741	Beef, round, uncooked.....	10.15	4.50	6.46	0	3.23	24.34	3.071
1751	Beef, round, cooked.....	.35	1.68	2.09	0	1.17	5.29	.597
1746	Broth percent uncooked meat.....	.77	3.03	3.98	0	2.19	9.97	1.096

C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.								
1741	Beef, round, uncooked.....	16.11	0	0	4.52	0.17	20.80	2.578
1751	Beef, round, cooked.....	33.98	0	0	7.12	.19	41.29	5.436
1746	Broth percent uncooked meat.....	.14	0	0	1.62	.....	1.76	.021
ON WATER-FREE BASIS.								
1741	Beef, round, uncooked.....	58.51	0	0	16.41	.62	75.54	9.362
1751	Beef, round, cooked.....	78.11	0	0	16.37	.44	94.92	12.497
1746	Broth percent uncooked meat.....	.48	0	0	5.88	.01	6.37	.076

<sup>a</sup> Cooked meat from sample No. 1746.



TABLE 80.—*Results of cooking (described in full, then cooked) experiment No. 136.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients—	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1746	In cooked meat.....	315.16	196.36	4.07	5.08	39.71	5.46
1746	In broth.....	397.28	1.45	4.55	10.95	58.18	5.06
1741	In uncooked meat.....	712.89	193.81	12.42	16.95	55.89	9.95
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
1746	In cooked meat.....	44.24	88.22	32.77	31.83	71.05	39.29
1746	In broth.....	55.76	1.78	67.23	68.31	28.95	60.80
1746	In broth on basis of total weight of uncooked meat...	39.78	.35	84	1.10	1.62	.31

## SERIES XII.—EXPERIMENTS NOS. 137-140.

The chief object of this, as of the preceding series, was to study the influence of previous browning of meats (1) upon the nature and quantity of the losses and (2) upon the chemical composition and nutritive value of boiled meats. Lean beef round from which all bone, gristle, and lumps of visible fat had been removed, was cut into 2-inch cubes, thoroughly mixed, and divided into five portions, four (samples Nos. 1754 to 1757) for cooking and one (No. 1753) for analysis.

## COOKING EXPERIMENT NO. 137.

In this test the weighed beef (sample No. 1754) was placed in 2,000 cubic centimeters of cold water and the water gradually heated, the flame being so regulated that at the end of the first hour the temperature had reached 85° C. The cooking was continued at this temperature for three hours. The broth from the cooked meat before diluting equaled 1,890 cubic centimeters.

The losses in weight in cooking were as follows:

Weight of meat before cooking.....	grams.....	900.00
Weight of meat after cooking.....	do.....	481.82
Loss in weight in cooking.....	do.....	418.18
Loss in weight in cooking.....	per cent.....	46.46

The results of the experiment are shown in detail in Tables 81 and 82.

TABLE 81.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 137.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
ON FRESH BASIS.									
1753	Beef, round, uncooked .....	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1754	Beef, round, cooked .....	73.65	19.23	1.11	1.52	4.24	1.07	27.17	3.433
1754	Beef, round, cooked .....	56.24	35.21	.78	.82	6.80	.70	44.31	5.884
1754	Broth(percent uncooked meat) .....		.54	.86	1.06	.86	.60	3.92	.363
ON WATER-FREE BASIS.									
1753	Beef, round, uncooked .....		72.98	4.21	5.77	16.09	4.06	103.11	13.028
1754	Beef, round, cooked .....		80.46	1.78	1.87	15.54	1.60	101.25	13.446
1754	Broth(percent uncooked meat) .....		2.05	3.27	4.01	3.28	2.27	14.88	1.377

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1753	Beef, round, uncooked .....		2.39	1.11	1.52	0	0.92	5.94	0.739
1758	Beef, round, cooked .....		.20	.78	.82	0	.55	2.35	.282
1754	Broth(percent uncooked meat) .....		.17	.86	1.06	0	.59	2.68	.304
ON WATER-FREE BASIS.									
1753	Beef, round, uncooked .....		9.09	4.21	5.77	0	3.47	22.54	2.805
1758	Beef, round, cooked .....		.46	1.78	1.87	0	1.25	5.36	.645
1754	Broth(percent uncooked meat) .....		.66	3.27	4.01	0	2.25	10.19	1.153

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1753	Beef, round, uncooked .....		16.84	0	0	4.24	0.15	21.23	2.694
1758	Beef, round, cooked .....		35.01	0	0	6.80	.15	41.96	5.602
1754	Broth(percent uncooked meat) .....		.37	0	0	.86	.01	1.24	.059
ON WATER-FREE BASIS.									
1753	Beef, round, uncooked .....		63.89	0	0	16.09	.59	80.57	10.223
1758	Beef, round, cooked .....		80.00	0	0	15.54	.35	95.89	12.801
1754	Broth(percent uncooked meat) .....		1.39	0	0	3.28	.02	4.69	.224

a Cooked meat from sample No. 1754.

TABLE 82.—*Results of cooking (boiling) experiment No 137.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
Weight of nutrients:		<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1754	In cooked meat .....	270.98	169.65	3.76	3.95	32.76	3.37
1754	In broth .....	382.90	4.87	7.75	9.51	7.77	5.38
1753	In uncooked meat .....	653.88	174.52	11.51	13.46	40.53	8.75
Proportion of nutrients:		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1754	In cooked meat .....	41.44	97.21	32.67	29.35	80.83	38.51
1754	In broth .....	58.56	2.79	67.33	70.65	19.17	61.49
1754	In broth on basis of total weight of uncooked meat...	42.54	.54	.86	1.06	.86	.60

## COOKING EXPERIMENT No. 138.

The second portion of beef round (sample No. 1755), cut into 2-inch cubes, was placed in 2,000 cubic centimeters of cold water, the temperature being in one hour gradually increased to the boiling point of water, and the cooking continued at this temperature for three hours. The broth from the cooked meat before diluting equaled 1,500 cubic centimeters.

The losses in weight in cooking were as follows:

Weight of meat before cooking .....	grams..	900.00
Weight of meat after cooking .....	do.....	483.34
Loss in weight in cooking .....	do.....	416.66
Loss in weight in cooking .....	per cent..	46.30

The detailed results of the experiment are shown in Tables 83 and 84.

TABLE 83.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 138.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Pro- teid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitro- gen.
				Nitrog- enous.	Non- nitrog- enous.				
	ON FRESH BASIS.								
1753	Beef, round, uncooked .....	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1755	Beef, round, cooked, .....	73.65	19.23	1.11	1.52	4.24	1.07	27.17	3.433
1755	Beef, round, cooked, .....	56.20	35.11	.74	.90	7.35	.71	44.81	5.857
	Broth (percent uncooked meat) .....		.57	.89	1.06	1.62	.63	4.77	.377
	ON WATER-FREE BASIS.								
1753	Beef, round, uncooked .....		72.98	4.21	5.77	16.09	4.06	103.11	13.028
1755	Beef, round, cooked, .....		80.16	1.69	2.06	16.78	1.62	102.31	13.372
1755	Broth (percent uncooked meat) .....		2.18	3.38	4.03	6.13	2.40	18.12	1.441

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1753	Beef, round, uncooked .....		2.39	1.11	1.52	0	0.92	5.94	0.739
1759	Beef, round, cooked <sup>a</sup> .....		.44	.74	.90	0	.42	2.50	.309
1755	Broth (percent uncooked meat) .....		.26	.89	1.06	0	.63	2.84	.327
ON WATER-FREE BASIS.									
1753	Beef, round, uncooked .....		9.09	4.21	5.77	0	3.47	22.54	2.805
1759	Beef, round, cooked <sup>a</sup> .....		1.00	1.69	2.06	0	.96	5.71	.706
1755	Broth (percent uncooked meat) .....		.98	3.38	4.03	0	2.40	10.79	1.240

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1753	Beef, round, uncooked .....		16.84	0	0	4.24	0.15	21.23	2.694
1759	Beef, round, cooked <sup>a</sup> .....		34.67	0	0	7.35	.29	42.31	5.548
1755	Broth (percent uncooked meat) .....		.31	0	0	1.62	.....	1.93	.050
ON WATER-FREE BASIS.									
1753	Beef, round, uncooked .....		63.89	0	0	16.09	.59	80.57	10.223
1759	Beef, round, cooked <sup>a</sup> .....		79.16	0	0	16.78	.66	96.60	12.666
1755	Broth (percent uncooked meat) .....		1.20	0	0	6.13	.....	7.33	.191

<sup>a</sup> Cooked meat from sample No. 1755.

TABLE 84.—*Results of cooking (boiling) experiment No. 138.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1755	In cooked meat .....	271.64	169.70	3.58	4.85	35.53	3.43
1755	In broth .....	373.69	5.16	8.01	9.56	14.54	5.70
1753	In uncooked meat .....	645.33	174.86	11.59	13.91	50.07	9.13
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1755	In cooked meat .....	42.09	97.05	30.89	31.27	70.96	37.57
1755	In broth .....	57.91	2.95	69.11	68.73	29.04	62.43
1755	In broth on basis of total weight of uncooked meat...	41.52	.57	.89	1.06	1.62	.63

## COOKING EXPERIMENT No. 139.

The third weighed portion of the beef round (sample No. 1756), in the form of 2-inch cubes, was browned or sautéed in 6.5 grams of beef fat for five minutes, and while still hot it was transferred to 2,000 cubic centimeters of cold water, care being taken to include all the browned material from the frying pan. The water was then slowly heated, the temperature at the end of an hour being 85° C. The cooking was continued at this temperature for three hours. The volume of the broth from the cooked meat before diluting equaled 1,740 cubic centimeters.

The losses in weight in cooking were as follows:

Weight of meat before cooking .....	grams..	900.00
Weight of meat after cooking .....	do....	518.20
Loss in weight in cooking .....	do....	381.80
Loss in weight in cooking .....	per cent..	42.42

Tables 85 and 86 give the results of the experiment in detail.

TABLE 85.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 139.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1753	Beef, round, uncooked .....	73.65	19.23	1.11	1.52	4.24	1.07	27.17	3.433
1756	Beef, round, cooked .....	57.22	32.84	.75	.75	8.00	.67	43.01	5.495
1756	Broth (percent uncooked meat) .....		.32	.87	1.06	.58	.61	3.44	.330
	ON WATER-FREE BASIS.								
1753	Beef, round, uncooked .....		72.98	4.21	5.77	16.09	4.06	103.11	13.028
1756	Beef, round, cooked .....		76.76	1.75	1.75	18.70	1.57	100.53	12.845
1756	Broth (percent uncooked meat) .....		1.21	3.30	4.02	2.22	2.33	13.08	1.253

TABLE 85.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 139—Continued.*

## B. NUTRIENTS SOLUBLE IN COLD WATER.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
ON FRESH BASIS.									
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1753	Beef, round, uncooked .....		2.39	1.11	1.52	0	0.92	5.94	0.739
1760	Beef, round, cooked <sup>a</sup> .....		.17	.75	.75	0	.50	2.17	.268
1756	Broth(percent uncooked meat).....		.17	.87	1.06	0	.61	2.71	.306
ON WATER-FREE BASIS.									
1753	Beef, round, uncooked .....		9.09	4.21	5.77	0	3.47	22.54	2.805
1760	Beef, round, cooked <sup>a</sup> .....		.40	1.75	1.75	0	1.16	5.06	.626
1756	Broth(percent uncooked meat).....		.65	3.30	4.02	0	2.32	10.29	1.163

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1753	Beef, round, uncooked .....	16.84	0	0	4.24	0.15	21.23	2.694	
1760	Beef, round, cooked <sup>a</sup> .....	32.67	0	0	8.00	.17	40.84	5.227	
1756	Broth(percent uncooked meat).....	.15	0	0	.58	.....	.73	.024	
ON WATER-FREE BASIS.									
1753	Beef, round, uncooked .....	63.89	0	0	16.09	.59	80.57	10.223	
1760	Beef, round, cooked <sup>a</sup> .....	76.36	0	0	18.70	.11	95.47	12.219	
1756	Broth(percent uncooked meat).....	.56	0	0	2.22	.01	2.79	.090	

<sup>a</sup> Cooked meat from sample No. 1756.TABLE 86.—*Results of cooking (browned in fat, then cooked) experiment No. 139.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1756	In cooked meat .....	296.51	170.18	3.89	3.89	41.46	3.47
1756	In broth.....	350.79	2.89	7.84	9.53	5.25	5.52
1753	In uncooked meat.....	647.30	173.05	11.73	13.42	46.71	8.99
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1756	In cooked meat .....	45.81	98.34	33.16	28.90	88.76	38.60
1756	In broth.....	54.19	1.66	66.84	71.10	11.24	61.40
1756	In broth on basis of total weight of uncooked meat ...	38.98	.32	.87	1.06	.58	.61

## COOKING EXPERIMENT No. 140.

The fourth weighed portion (sample No. 1757) of 2-inch cubes of beef round, was browned or sautéed in 7 grams of beef fat for five minutes, and then while hot it was transferred to 2,000 cubic centimeters of cold water, care being taken to include all browned material adhering to the frying pan. One hour was required to gradually increase the temperature to that of boiling water, and the cooking was continued at this temperature for three hours. The volume of the final broth before diluting equaled 1,260 cubic centimeters.



The losses in weight in cooking were as follows:

Weight of meat before cooking .....	grams..	900.00
Weight of meat after cooking .....	do.....	495.72
Loss in weight in cooking .....	do.....	404.28
Loss in weight in cooking .....	per cent..	44.92

The detailed results of the experiment are given in Tables 87 and 88.

TABLE 87.—*Constituents of uncooked meats, cooked meats, and broths, soluble and insoluble in cold water, experiment No. 140.*

A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
ON FRESH BASIS.									
1753	Beef, round, uncooked .....	73.65	19.23	1.11	1.52	4.24	1.07	27.17	3.433
1757	Beef, round, cooked .....	56.45	35.01	.79	.91	6.83	.70	44.24	5.855
1757	Broth (percent uncooked meat) .....		.37	.89	1.08	.65	.64	3.63	.345
ON WATER-FREE BASIS.									
1753	Beef, round, uncooked .....		72.98	4.21	5.77	16.09	4.06	103.11	13.028
1757	Beef, round, cooked .....		80.39	1.81	2.09	15.68	1.01	101.58	13.444
1757	Broth (percent uncooked meat) .....		1.41	3.39	4.11	2.46	2.41	13.78	1.311

B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1753	Beef, round, uncooked .....		2.39	1.11	1.52	0	0.02	5.94	0.739
1761	Beef, round, cooked <sup>a</sup> .....		.49	.79	.91	0	.52	2.71	.332
1757	Broth (percent uncooked meat) .....		.25	.89	1.08	0	.63	2.85	.325
ON WATER-FREE BASIS.									
1753	Beef, round, uncooked .....		9.09	4.21	5.77	0	3.47	22.54	2.805
1761	Beef, round, cooked <sup>a</sup> .....		1.13	1.81	2.09	0	1.20	6.23	.763
1757	Broth (percent uncooked meat) .....		.93	3.39	4.11	0	2.40	10.83	1.235

C. NUTRIENTS INSOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1753	Beef, round, uncooked .....		16.81	0	0	4.24	0.15	21.23	2.694
1761	Beef, round, cooked <sup>a</sup> .....		34.52	0	0	6.83	.18	41.53	5.323
1757	Broth (percent uncooked meat) .....		.12	0	0	.65	.01	.78	.020
ON WATER-FREE BASIS.									
1753	Beef, round, uncooked .....		63.89	0	0	16.09	.59	80.57	10.223
1761	Beef, round, cooked <sup>a</sup> .....		79.26	0	0	15.68	.41	95.33	12.681
1757	Broth (percent uncooked meat) .....		.48	0	0	2.46	.01	2.95	.076

<sup>a</sup> Cooked meat from sample No. 1761.



TABLE 88.—*Results of cooking (browned in fat, then boiled) experiment No 140.*

Laboratory No.	Distribution of nutrients.	Water.	Proteid.	Organic extractives.		Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.		
	Weight of nutrients:	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1757	In cooked meat .....	279.83	173.55	3.92	4.51	33.86	3.47
1757	In broth .....	371.60	3.34	8.03	9.75	5.84	5.72
1753	In uncooked meat .....	651.43	176.89	11.95	14.26	39.70	9.19
	Proportion of nutrients:	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1757	In cooked meat .....	42.96	98.11	32.80	31.63	85.29	37.76
1757	In broth .....	57.04	1.89	67.20	68.37	14.71	62.24
1757	In broth on basis of total weight of uncooked meat...	41.29	.37	.89	1.08	.65	.64

### MEATS COOKED BY BROILING—DIFFERENCE IN SURFACE AND INTERIOR OF SAMPLE.

#### SERIES XIII.—EXPERIMENT NO. 157.

The special objects of this experiment were (1) to determine if possible how the cooking of meat by broiling developed flavor, and (2) to find out the nature of the chemical changes resulting when meats are thus cooked. A steak 1.75 inches thick, the fourth cut taken from the sirloin from an animal said to be about two years old, was cooked by gas broiling for twenty minutes. When cold the cooked meat was freed from visible fat and divided into three portions as follows: The thin, browned, outer surface (sample No. 1687) was cut away with a sharp knife, as little as possible of the gray layer immediately underneath being removed with it. It had an agreeable meaty flavor, suggesting the savory odors given off from broiling or roasting meat, though it seemed rather dry. For the second sample (No. 1698) the gray layer, about one-fourth of an inch thick in depth, next the outer brown surface was removed. This sample had a more pronounced and pleasing flavor than sample No. 1687 or the inner portion, No. 1689. It seemed to have lost some of the uncooked taste of the interior portion and to have acquired a little of the savoriness of the outer browned surface.

The inner portion of the steak (sample No. 1689) which was left after removing the outer layers was decidedly underdone, or rare, and had a very pleasant, fresh, meaty flavor and odor, in these respects more nearly resembling uncooked meat than the outer or the middle layer. These three samples and a portion of the uncooked meat were analyzed.

The losses in weights during cooking were as follows:

Weight of meat before cooking .....	grams..	2,452.23
Weight of meat after cooking .....	do....	1,991.55
Loss in weight in cooking .....	do....	460.68
Loss in weight in cooking .....	per cent..	18.79

The results of the experiments are shown in detail in Table 89.

TABLE 89.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 157.*

## A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitro- gen.
				Nitrog- enous.	Non- nitrog- enous.				
ON FRESH BASIS.									
1685	Beef, sirloin, uncooked .....	60.39	16.07	0.84	1.39	20.89	1.11	40.30	2.810
1687	Beef, sirloin, cooked, browned surface .....	48.47	24.54	1.36	1.73	23.70	1.33	52.66	4.363
1688	Beef, material next browned surface .....	62.68	23.44	1.15	1.75	11.20	1.18	38.72	4.119
1689	Beef, inner portion.....	70.23	20.28	1.14	1.66	7.45	1.02	31.55	3.611
ON WATER-FREE BASIS.									
1685	Beef, sirloin, uncooked .....		40.57	2.12	3.51	52.74	2.80	101.74	7.169
1687	Beef, sirloin, cooked, browned surface .....		47.62	2.64	3.36	45.99	2.58	102.19	8.467
1688	Beef, material next browned surface .....		62.81	3.08	4.69	30.01	3.16	103.75	11.037
1689	Beef, inner portion.....		68.12	3.83	5.58	25.03	3.43	105.99	12.129

## B. NUTRIENTS SOLUBLE IN COLD WATER.

ON FRESH BASIS.									
1685	Beef, sirloin, uncooked .....		1.81	0.84	1.39	0	0.77	4.81	0.559
1687	Beef, sirloin, cooked, browned surface .....		.52	1.36	1.73	0	1.04	4.65	.520
1688	Beef, material next browned surface .....		.72	1.15	1.75	0	1.04	4.66	.484
1689	Beef, inner portion .....		1.21	1.14	1.66	0	.92	4.93	.560
ON WATER-FREE BASIS.									
1685	Beef, sirloin, uncooked .....		4.57	2.12	3.51	0	1.91	12.14	1.410
1687	Beef, sirloin, cooked, browned surface .....		1.01	2.64	3.36	0	2.02	9.03	1.039
1688	Beef, material next browned surface .....		1.93	3.08	4.69	0	2.79	12.49	1.297
1689	Beef, inner portion .....		4.06	3.83	5.58	0	3.09	16.56	1.880

## C. NUTRIENTS INSOLUBLE IN COLD WATER

ON FRESH BASIS.									
1685	Beef, sirloin, uncooked .....	14.26	0	0	20.89	0.34	35.49	2.281	
1687	Beef, sirloin, cooked, browned surface .....	24.02	0	0	23.70	.29	48.01	3.843	
1688	Beef, material next browned surface .....	22.72	0	0	11.20	.14	34.06	3.635	
1689	Beef, inner portion .....	19.07	0	0	7.45	.10	26.62	3.051	
ON WATER-FREE BASIS.									
1685	Beef, sirloin, uncooked .....	36.00	0	0	52.74	.86	89.60	5.760	
1687	Beef, sirloin, cooked, browned surface .....	46.61	0	0	45.99	.56	93.16	7.458	
1688	Beef, material next browned surface .....	60.88	0	0	30.01	.37	91.26	9.740	
1689	Beef, inner portion .....	64.06	0	0	25.03	.34	89.43	10.249	

## MEAT JUICE AND MEAT FIBER COOKED IN DIFFERENT WAYS.

## SERIES XIV.—EXPERIMENTS NOS. 148, 149.

The object of this series was (1) to determine, if possible, whether it is the soluble or the insoluble constituents of meats which upon cooking are so changed as to produce the characteristic flavor of cooked meats, and (2) to learn whether or not the insoluble constituents of meat are made soluble by the process of cooking. No experiments of this nature have been thus far reported in connection with the nutrition investigations made in this laboratory. Fresh lean beef round, from which all bone, gristle, and visible fat were removed, was selected. The entire cut, weighing about 5 pounds, was divided into strips and then passed through a sausage mill four times, being mixed well after each grinding. A sample (No. 1677) of the thoroughly mixed meat was reserved for analysis, the results of which are given in the tables in connection with cooking experiment No. 149 (pp. 90-94).

The remainder of the finely divided meat was used for the preparation of meat juice and meat fiber, as follows: The entire quantity, about 4.5 pounds, was placed in a compound screw press, in portions weighing about 1.75 pounds each, and subjected to as much pressure as possible. About 700 cubic centimeters of meat juice were obtained. The meat fiber was now thoroughly moistened with cold distilled water (700 cubic centimeters), intimately mixed by kneading with the hands for thirty minutes, and again pressed, yielding about 800 cubic centimeters of liquid. The material remaining in the press was again moistened with water (700 cubic centimeters) and pressed, when about 900 cubic centimeters of liquid were recovered. The three quantities of liquid thus removed were combined, making 2,300 cubic centimeters in all, diluted with water to 2,500 cubic centimeters, thoroughly mixed, set aside, and designated sample No. 1678. The meat fiber left after pressing out the juice (sample No. 1679) was used for cooking experiment No. 149.

## COOKING EXPERIMENT No. 148.

The meat juice (sample No. 1678) was divided into six portions of 400 cubic centimeters each. One portion of the fresh juice was subjected to complete analysis in triplicate, the results obtained being given in Tables Nos. 90 and 91. The results have been calculated to show the amount of the different kinds of nitrogenous constituents and the total quantity of proximate constituents in 2,500 cubic centimeters of the meat juice.

TABLE 90.—*Weights in grams of the different forms of nitrogen in the 2,500 cubic centimeters of expressed beef juice, experiment No 148.*

Laboratory No.	In unfiltered juice.			In filtered juice.				
	Total nitrogen.	Insoluble nitrogen.	Soluble nitrogen.	Coagulated by heat.	Precipitated by $\text{ZnSO}_4$ .	Proteid nitrogen.	Nonproteid nitrogen.	Precipitated by bromin directly.
	<i>Grams.</i>	<i>Gram.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Gram.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1678a .....	9.629	0.304	9.325	5.824	0.158	5.982	3.343	4.721
1678b .....	9.339	.326	9.013	5.889	.145	6.034	2.979	4.742
1678c .....	9.700	.350	9.350	5.891	.265	6.156	3.194	.....
Average .....	9.556	.327	9.229	5.868	.189	6.057	3.172	4.732

TABLE 91.—*Weights in grams of the nutrients in the 2,500 cubic centimeters of expressed beef juice, experiment No. 148.*

Laboratory No.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
		Nitrogenous.	Nonnitrogenous.				
	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
1678a .....	39.288	10.430	16.845	0	11.156	77.719	9.629
1678b .....	39.750	9.294	17.394	0	10.531	76.969	9.339
1678c .....	40.663	9.965	15.331	0	10.812	76.781	9.700
Average .....	39.900	9.896	16.527	0	10.833	77.156	9.556

The second portion of the meat juice (sample No. 1678a) was placed on a water bath and heated gradually to  $65^{\circ}\text{C}$ . By the time the temperature had reached  $52^{\circ}\text{C}$ . a considerable amount of coagulated albumin had separated, and the liquid, while still retaining some of its original color, was beginning to turn brown. At  $55^{\circ}\text{C}$ . almost all the red color had disappeared and the liquid began to change to a grayish brown. At  $65^{\circ}\text{C}$ . the mixture had a very disagreeable alkaline taste, which "puckered" the tongue. No pleasant, meaty flavor could be detected. The temperature was maintained at  $65^{\circ}\text{C}$ . for one hour, but the continued cooking at this low temperature produced no noticeable change in flavor. For a comparison of the tastes of the coagulated cooked residue and the resulting clear filtrate, see the description of portion No. 1678e, page 89.

The third portion of meat juice (sample No. 1678b) was gradually heated upon the water bath until it reached a temperature of  $83^{\circ}\text{C}$ ., and the cooking was continued at this temperature for one hour. Careful tests of the precipitate and the filtrate did not show any differences in taste or odor between this sample and No. 1678a or No. 1678c and No. 1678e, described below, cooked at about  $100^{\circ}\text{C}$ .

The fourth portion of meat juice (sample No. 1678c) was cooked with constant stirring for one hour at the temperature of boiling water upon an asbestos mat over a gas flame. The mixture was not noticeably different in taste from that obtained with sample No. 1678a. It was filtered to remove the coagulated material and washed thoroughly with hot water. The precipitate retained the characteristic strongly

alkaline taste. The filtrate had only a slight alkaline taste and a very slight meaty flavor.

The fifth measured portion of meat juice (sample No. 1678d) was placed in an evaporating dish and carefully and slowly evaporated nearly to dryness on a hot plate, with constant stirring during the latter part of the process to prevent browning. Savory odors were given off before evaporation was complete and a thin coating of a reddish-brown material was noted on the side of the dish at the first level of the liquid. After evaporating almost to dryness the solid matter had some savory, meaty flavor, but the alkaline taste was still very strong. To prevent further browning of the savory products already formed the solid residue was transferred to a clean dish and heated at  $130^{\circ}$  C. for two hours. When thoroughly dried the material was pounded in a mortar to break up the hard lumps and permit uniform browning. The resulting product was a dark, reddish-brown, granular powder, having very little taste. A few grams added to hot water colored the water slightly and gave to the solution a very slight flavor. The alkaline taste still persisted, even in the brown coating produced on the side of the evaporating dish.

The sixth measured portion of meat juice (sample No. 1678e) was boiled for one hour and the coagulated and cooked proteid removed by filtration, the insoluble residue being thoroughly washed with hot water. Upon heating, a small additional quantity of coagulated albumin appeared in the filtrate. The liquid was reduced one-half in volume, again filtered, and the filtrate further evaporated. The concentrated solution had still a very slight alkaline taste, accompanied by a slight savory odor and pleasant flavor. The evaporation was very slowly and carefully continued, with constant stirring in such a way as to wash down the brownish colored substance formed on the side of the dish, and at the same time the sides of the dish were protected with asbestos paper to prevent any overbrowning. When evaporated until of a rich light-brown color and sirupy consistency, the liquid had a flavor very similar to that of commercial meat extract with the acid taste strongly emphasized. The browning was continued in an oven at  $130^{\circ}$  C. until the material had acquired a rich dark-brown color. Very little odor could be detected. The flavor seemed to be somewhat though not very greatly increased by the additional heating in the oven. A small amount of the material dissolved in water had a taste which closely resembled that of ordinary commercial beef extract of like dilution.

The precipitate obtained from sample No. 1678e, as described above, retained its strongly alkaline taste even after being well washed. It was placed in an evaporating dish and heated in an air oven at  $130^{\circ}$  C. for three hours. Both odor and taste were somewhat improved by this treatment, the alkaline taste seeming a little less strong and some



savory odor being developed. The material was then further heated in an oven at 130° C. until it was thoroughly dry, and was then finely ground in a mortar to insure uniform browning and again heated. The final product was a dry, grayish-brown or black granular substance, with a very faint odor and practically tasteless. A few grams added to distilled water and boiled did not cause coloration of the water or yield any flavor.

COOKING EXPERIMENT No. 149.

In this experiment the residue (No. 1679) left after expressing and dissolving out the meat juice (see p. 87) was thoroughly mixed, passed twice through a sausage mill, again thoroughly mixed, and divided into seven approximately equal portions, which were used for the tests described below.

The first portion (sample No. 1679) was analyzed without further treatment, the results being given with the other details of the experiment in Tables 92, 93, and 94.

The second portion (sample No. 1679a), weighing 208.41 grams, was made into a ball, tied in cheese cloth, placed in a beaker containing 417 cubic centimeters of water at 65° C., and cooked at this temperature for three hours. During the cooking a rather faint odor somewhat resembling that of melted fat was noticeable. At the end of the cooking period the meat fiber was removed from the liquid and the flavor of each tested. The cooked meat fiber was rather light in color and had a very slight alkaline flavor which resembled that of the meat juice. The broth or liquid in which the extracted meat was cooked had a reddish-yellow tinge and very little flavor. The results of the analysis of the cooked meat and the broth are given in Tables 93 and 94.

The third portion of the extracted meat (sample No. 1679b), weighing 161.36 grams, was placed in a beaker containing twice its weight (322 grams) of boiling water, the temperature of the water reduced to 85° C., and the meat cooked at this temperature for three hours. During the cooking a faint but pleasant odor was given off. The cooked meat was darker in color than in the case of sample No. 1679a and had only a very slight flavor. The broth or liquid in which the extracted meat was cooked had a clear, light yellow color and a rather weak though pleasant flavor. The results of the analysis of the cooked meat and the broth are given in Tables 93 and 94.

The fourth portion of the extracted meat fiber (sample No. 1679c), weighing 162.55 grams, was placed in a beaker containing twice its weight (325 cubic centimeters) of boiling water and gently boiled for three hours. During the cooking a very pleasant and savory odor was noticeable. The cooked product was much darker in color than the other samples (Nos. 1679a and 1679b), and was very dry and some-



what difficult to masticate and swallow. The broth or liquid in which the extracted meat was cooked had a clear, bright yellow color and a decidedly better flavor than those from samples Nos. 1679a and 1679b. The results of the analysis of the cooked meat and the broth are given in Tables 93 and 94.

The fifth portion of the extracted meat fiber (sample No. 1679d), weighing 236.04 grams, was made into a small loaf and roasted in a gas oven at 193° C. for forty-five minutes. There was a thin, well-browned layer on the outside of the loaf, while the inside was rather moist and the fiber was soft and easy to masticate and swallow. The cooked material had a pleasant though faint meaty flavor, the outer crust being somewhat superior in these respects to the inside portion. The results of the chemical analysis of the cooked meat are given in Table 94.

The sixth portion of the extracted fiber (sample No. 1679e), weighing 206.4 grams, was made into a flat cake 1 inch in thickness, and broiled for twenty minutes over the flame of a gas broiler, each side of the cake being exposed to the direct flame for ten minutes. When cooked, the upper side of the cake was fairly well browned, and the lower side was browned in some places, while in others it was unchanged or only slightly yellowed. The cooked meat fiber was very dry and difficult to masticate and swallow and had only a slight flavor, although the outside layer had a somewhat more pronounced taste than the inside. The juice which exuded from the meat during the cooking was burned on the pan. Tables 92-94 summarize the data of the cooking tests.

TABLE 92.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 149.*

A. TOTAL NUTRIENTS IN ORIGINAL SUBSTANCE.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1677	Beef, round, raw .....	74.01	18.71	1.21	3.13	4.63	1.05	28.73	3.382
1679	Beef, round, extracted meat ..	77.61	17.77	.47	.96	4.35	.52	24.07	2.993
	ON WATER-FREE BASIS.								
1677	Beef, round, raw .....		71.99	4.66	12.04	17.81	4.04	110.54	13.013
1679	Beef, round, extracted meat ..		79.37	2.09	4.28	19.43	2.32	107.49	13.367

B. NUTRIENTS SOLUBLE IN COLD WATER.

	ON FRESH BASIS.								
1677	Beef, round, raw .....		2.44	1.21	3.13	0	0.84	7.62	0.779
1679	Beef, round, extracted meat ..		.66	.47	.96	0	.39	2.48	.256
	ON WATER-FREE BASIS.								
1677	Beef, round, raw .....		9.39	4.66	12.04	0	3.24	29.33	2.998
1679	Beef, round, extracted meat ..		2.95	2.09	4.28	0	1.74	11.06	1.142

TABLE 92.—*Constituents of uncooked meats and cooked meats soluble and insoluble in cold water, experiment No. 149—Continued.*

## C. NUTRIENTS INSOLUBLE IN COLD WATER.

Laboratory No.	Kind of material.	Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.	Total nitrogen.
				Nitrogenous.	Non-nitrogenous.				
	ON FRESH BASIS.	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1677	Beef, round, raw .....		16.27	0	0	4.63	0.21	21.11	2.603
1679	Beef, round, extracted meat .....		17.11	0	0	4.35	.13	21.59	2.737
	ON WATER-FREE BASIS.								
1677	Beef, round, raw .....		62.60	0	0	17.81	.80	81.21	10.014
1679	Beef, round, extracted meat ..		76.42	0	0	19.43	.58	96.43	12.225

TABLE 93.—*Results of cooking experiment No 149.*

Laboratory No.	Method of cooking.					Nutrients in broth expressed in percentage of fresh substance.				
	Weight of meat taken.	Amount of water taken.	Temperature.		Duration of cooking.	Proteid.	Organic extractives.		Ash.	Total solid matter.
			At beginning.	During cooking.			Nitrogenous.	Non-nitrogenous.		
	<i>Grams.</i>	<i>Cc.</i>	<i>°C.</i>	<i>°C.</i>	<i>Hours.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1679a ....	208.41	417	65	65	3	0.13	0.24	0.33	0.18	0.88
1679b ....	161.36	323	85	85	3	.10	.28	.37	.21	.96
1679c ....	162.55	325	100	100	3	.22	.26	.33	.19	1.00

TABLE 94.—*Results of the analysis of cold water extracts of meats used in cooking experiment No. 149.*

Laboratory No.	Kind of meat.	Water in fresh substance.	Method of cooking.			
			Temperature.		Duration of cooking.	
			At beginning.	During cooking.		
		<i>Per cent.</i>	<i>°C.</i>	<i>°C.</i>	<i>Hours.</i>	
1677	Beef, round, unextracted, uncooked.....	74.01				
1679	Beef, round, extracted, uncooked .....	77.61				
1679a	Beef, round, extracted, boiled .....	66.50	65	65	3	
1679b	Beef, round, extracted, boiled .....	61.17	85	85	3	
1679c	Beef, round, extracted, boiled .....	61.77	100	100	3	
1679d	Beef, round, extracted, roasted .....	65.70	193	193	3	
1679e	Beef, round, extracted, gas broiled .....	53.87				

Laboratory No.	Kind of meat.	Nutrients soluble in cold water expressed in percentage of fresh substance.					
		Proteid.	Organic extractives.		Ash.	Total solid matter.	Total nitrogen.
			Nitrogenous.	Non-nitrogenous.			
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1677	Beef, round, unextracted, uncooked.....	2.44	1.21	3.13	0.84	7.63	0.779
1679	Beef, round, extracted, uncooked .....	.66	.47	.39	.39	1.91	.256
1679a	Beef, round, extracted, boiled .....	.17	.38	.44	.26	1.25	.147
1679b	Beef, round, extracted, boiled .....	.13	.31	.36	.21	1.01	.121
1679c	Beef, round, extracted, boiled .....	.48	.34	.36	.19	1.37	.186
1679d	Beef, round, extracted, roasted .....	.29	.71	.99	.52	2.51	.273
1679e	Beef, round, extracted, gas broiled.....	.18	.86	1.12	.66	2.82	.305

TABLE 94.—*Results of the analysis of cold water extracts of meats used in cooking experiment No. 149—Continued.*

Laboratory No.	Kind of meat.	Nutrients soluble in cold water calculated to water-free basis.					
		Proteid.	Organic extractives.		Ash.	Total solid matter.	Total nitrogen.
			Nitrogenous.	Non-nitrogenous.			
		<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1677	Beef, round, unextracted, uncooked.....	9.31	4.66	12.04	3.23	29.27	2.997
1679	Beef, round, extracted, uncooked.....	2.95	2.10	1.74	1.74	8.53	1.143
1679a	Beef, round, extracted, boiled.....	.51	1.13	1.31	.78	3.73	.439
1679b	Beef, round, extracted, boiled.....	.34	.80	.93	.54	2.61	.312
1679c	Beef, round, extracted, boiled.....	1.26	.89	.94	1.50	3.59	.487
1679d	Beef, round, extracted, roasted.....	.85	2.07	2.89	1.52	7.33	.796
1679e	Beef, round, extracted, gas broiled.....	.39	1.86	2.43	1.43	6.11	.661

The changes noted in these experiments may be briefly summarized as follows: When the juice is expressed from meat the fiber is grayish in color and the juice red; that is, the characteristic color of raw meat is due to coloring matters in solution. In cooking meat the coagulation of proteid existing in liquid form begins at 52° C. and continues as the temperature increases, the precipitation being practically complete at 100°. At 52° the red color of the meat juice begins to change to brown, the color changes becoming more pronounced as the temperature increases. At 65° an unpleasant alkaline flavor develops in the juice which is not modified by continued cooking at 65° to 100°. The flavor is more pronounced in the liquid portion of the meat juice than in the coagulated precipitate. At temperatures considerably over 100° and high enough to cause browning, savory flavors are developed which are much more pronounced in the liquid portion (extractives) than in the solid portion (proteid) of the meat juice, the flavor being very much like that of commercial meat extract. The fiber of the meat from which the juice is expressed had little distinctive flavor when cooked in different ways. Temperatures high enough to cause browning produced the most flavor.

These tests indicate that the changes produced in the juice or soluble part of meat by temperatures considerably over 100° are in a large measure responsible for the characteristic flavors of meat cooked by dry heat. In these tests fat was not studied, as the meat used was quite free from visible fat. Meat fats have a characteristic flavor which becomes more pronounced on cooking, and when the temperature is high enough to brown some of the fat the flavor is markedly increased. This browning or oxidation of fats and other bodies is of course due to their cleavage by heat. The nature of the chemical compounds formed has not been studied, so far as can be learned, with special reference to the fats, proteids, and extractives of flesh foods, though many studies of the oxidation products of typical fats, proteids, and other bodies have been reported. The collection and discussion

of such material is an important matter, and studies with special reference to the bodies existing in fats are needed. From the investigations made in this laboratory and other available data, it seems fair to conclude that the flavors developed in the cooking of meat by the ordinary household methods are due very largely to the oxidation of extractive bodies in the meat juice and to the oxidation of fat.

#### **BEEF BONES COOKED AS IN SOUP MAKING.**

##### **SERIES XV.—EXPERIMENTS NOS. 127–130.**

The four experiments included in this series were made with bones rather than meat in order to investigate the losses and changes which they sustain when cooked in hot water at different temperatures, as in ordinary household soup making.

In general the same methods were followed as in the tests in which meat was boiled, save that no attempt has as yet been made to analyze the bones before and after cooking. So far the amount and nature of the substances which bones yield when cooked in hot water have been determined entirely from the chemical composition of the resulting broths.

For the first two experiments (Nos. 127 and 128) beef rib bones, scraped to remove as much of the meat as possible, chopped into pieces from 0.5 to 1 inch in length, and thoroughly mixed, were divided into two portions, each weighing 1,000 grams. The first portion, for experiment No. 127, was placed in 2,000 cubic centimeters of vigorously boiling water and cooked for five hours. The resulting soup or broth was filtered and analyzed according to the methods described in an earlier section.

The second portion of bones (experiment No. 128) was cooked in 2,000 cubic centimeters of distilled water for ten minutes at the temperature of boiling water and for five hours at a considerably lower temperature, i. e., 84° or 85° C. The soup or broth was analyzed in the same way as the meat broths.

For the last two experiments of this series (Nos. 129 and 130) beef shank bones were scraped to remove as much of the meat as possible, sawed into pieces about 1.5 to 2 inches long, thoroughly mixed and divided into two portions weighing 1,000 grams each. The first portion (experiment No. 129) was placed in 2,000 cubic centimeters of vigorously boiling water and cooked at this temperature for five hours. The resulting broth was subjected to the usual treatment and analysis.

The second portion of shank bones (experiment No. 130) was cooked in 2,000 cubic centimeters of distilled water for ten minutes at the temperature of boiling water and for five hours at 84° to 85° C.

The results of these four experiments are given together in Tables 95 and 96.

TABLE 95.—*Results of cooking experiments Nos. 127-130.*

Cooking experiment No.	Laboratory No.	Kind of bones.	Weight before cooking.	Weight after cooking.	Loss (-) or gain (+) in weight in cooking.	Per cent loss (-) or gain (+) in cooking.
			<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>	<i>Grams.</i>
127.....	1707	Rib .....	1,000.00	1,012.55	+ 12.55	+ 1.26
128.....	1708	Rib .....	1,000.00	1,029.35	+ 29.35	+ 2.94
129.....	1709	Shank .....	1,000.00	894.00	-106.00	-10.60
130.....	1710	Shank .....	1,000.00	871.52	-128.48	-12.85

TABLE 96.—*Composition of broths from cooking experiments Nos. 127-130.*

Ex-periment No.	Labo-ratory No.	Method of cook-ing.			Weight of nutrients in broths.						Nutrients in broths expressed in percentage of total weight of the uncooked bone.					
		Tempera-ture.		Dura-tion of cook-ing.	Pro-teid.	Organic extractives.		Fat.	Ash.	Pro-teid.	Organic extractives.		Fat.	Ash.		
		At be-gin-nig.	Dur-ing cook-ing.			Ni-trog-enous.	Non-nitrog-enous.				Ni-trog-enous.	Non-nitrog-enous.				
127 ...	1707	° C.	° C.	Hrs.	Grams	Grams	Grams.	Grs.	P. ct.	Per ct.	Per ct.	Per ct.	P. ct.			
128 ...	1708	100	100	5	14.61	1.40	6.61	20.16	1.20	1.46	0.14	0.66	2.02	0.12		
129 ...	1709	100	85	5	5.84	1.21	3.83	13.44	1.34	.58	.12	.38	1.34	.13		
129 ...	1709	100	100	5	1.25	.83	1.48	75.63	.57	.13	.08	.15	7.56	.06		
130 ...	1710	100	85	5	2.49	1.30	1.69	126.56	1.08	.25	.13	.17	12.66	.11		

In experiments 127 and 128 with rib bones the percentages of nutrients, in terms of the total weight of the uncooked bone, were as follows: Proteid 1.02, nitrogenous extractives 0.13, nonnitrogenous extractives 0.52, fat 1.68, and ash 0.13. In experiments 129 and 130, in which shank bones were used, the corresponding percentages of nutrients were: Proteid 0.19, nitrogenous extractives 0.11, nonnitrogenous extractives 0.16, fat 10.11, and ash 0.09. From these results it appears that the nutritive matter other than fat obtained from the small, spongy rib bones is greater than that from the larger and more compact shank bones. The shank bones, however, are generally preferred for soup making, possibly because of a certain flavor imparted by the marrow, which is so abundant. Aside from the fat content, the amount of nutrients in bones is small, and it is evident, therefore, that the bones contribute very little to the value of the broth.

### DISCUSSION OF RESULTS.

In studies of the composition of food comparatively few analyses of flesh have previously been reported in which the proteid nitrogen has been differentiated from the nonproteid nitrogen, and so far as the writers are aware none have been reported which indicate the total amount of nonnitrogenous extractives, though considerable work has been published regarding the amount of glycogen and other carbohydrates of meat. In most cases the total nitrogen directly



determined is all reported as from proteid substances. In some cases, however, the proteids are subdivided into albumin, gelatinoids, and insoluble proteid. If space allowed it would be interesting in this connection to describe the pioneer work of Berzelius, Liebig, Mole-schott, Schlossberger, and Bibra on the chemistry of flesh. It is hoped that time and opportunity may in the future be afforded for a thorough résumé of their researches.

#### COMPOSITION OF UNCOOKED MEATS.

The limited amount of work on such lines is shown by the fact that König,<sup>a</sup> who devotes 70 pages to the chemical analyses of various kinds of fresh meats in his extended compilation of data on the composition of food, refers to only three investigations in which an attempt has been made to distinguish between proteid and nonproteid nitrogen.

One of these investigations made by W. Henneberg, E. Kern, and H. Wattenberg<sup>b</sup> reports the analyses of 7 different cuts of mutton from each of two animals in which the combined extractives, the soluble proteids, the nonproteid organic extractives, and the ash are given. The method used by these investigators and others cited will be briefly referred to in connection with the discussion of the cold-water extracts of meat (p. 122). At present it suffices to say that Henneberg, Kern, and Wattenberg found that on the average fresh, fat-free mutton flesh had the following composition: Water 79.22 per cent, insoluble proteids 15.79 per cent, and total soluble matter 5 per cent, including albumin 1.61 per cent, nonproteid organic extractives 2.18 per cent, and ash 1.21 per cent. Almen<sup>c</sup> reported analyses of 13 different sorts of fish, albumin, organic nonproteid extractives, and proteids soluble in hot water (gelatinoids) being determined. It will be of interest to state that Almen obtained as an average of the above analyses of fish the following results: Water 64.24 per cent, albumin 2.09 per cent, extractives 2.56 per cent, gelatinoids 2.55 per cent, insoluble proteids 12.10 per cent, total nitrogenous matter 19.31 per cent, fat 9.44 per cent, and ash 7.34 per cent.

A study of the extractives of flesh was made by W. O. Atwater<sup>d</sup> and associates in the course of an extended investigation of the chemical composition and economic values of fish and invertebrates used for food. In the case of 30 specimens of fish, the albumin, the organic nonproteid extractives, the proteids soluble in hot water (gelatinoids), and the insoluble proteids were determined. As an average of the analyses of 24 samples of the edible portion of the flesh of fresh fish

<sup>a</sup> *Chemie der menschlichen Nahrungs- und Genussmittel*. 4 ed., I, p. 185.

<sup>b</sup> *Jour. Landw.*, 26 (1878), p. 549.

<sup>c</sup> *Analyse des Fleisches einiger Fische*. Upsala, 1877.

<sup>d</sup> *Amer. Chem. Jour.*, 9 (1887), p. 421. *Ber. Deut. Chem. Gesell.*, 16 (1883), p. 1839.



they obtained the following results: Water 75.52 per cent, albumin 1.55 per cent, extractives 1.95 per cent, gelatinoids 2.85 per cent, insoluble proteid 11.60 per cent, fat 5.13 per cent, and ash 1.33 per cent. The analyses of the edible portion of 7 samples of cured fish gave them the following average results: Water 50.53 per cent, albumin 0.61 per cent, extractives 3.66 per cent, gelatinoids 3.01 per cent, insoluble proteid 15.86 per cent, fat 9.75 per cent, and ash 15.87 per cent.

An extended study of the chemical composition of the carcasses of 8 pigs was made by H. W. Wiley, with the collaboration of E. E. Ewell, W. H. Krug, T. C. Trescot, and others.<sup>a</sup> The carcasses were divided into 11 parts or cuts, and proteids insoluble in hot water, gelatinoids, and flesh bases, together with other constituents, were determined in air-dried samples of each cut. The average composition of the 8 pigs, expressed in percentages of the entire dressed animals, was as follows: Water, 36.43; fat, 49.67; proteids insoluble in water, 8.12; gelatinoids, 1.10; flesh bases, 1.14; total nitrogenous substances, 10.46; lecithin, 0.023; ash, 2.11; total, 98.90.

Mention must also be made of the work of Gautier,<sup>b</sup> who reported a very complete analysis of fresh mutton (neck and shoulder) and fresh beefsteak. Unfortunately, in spite of considerable effort, we have been unable to learn much regarding the methods followed by this investigator. His results will be considered in detail below in connection with the discussion of the cold-water extracts of meat. For purposes of comparison we have taken the liberty of putting Gautier's analytical results in approximately the same form as those mentioned above. The data are: For fresh beefsteak—water, 74.75 per cent; insoluble proteids, 15.50 per cent; coagulable proteid, 3.06 per cent; nonproteid organic extractives, 3.59 per cent; fat, 1.97 per cent, and ash, 1.09 per cent; and for fresh mutton—water, 74.92 per cent; insoluble proteids, 13.66 per cent; coagulable proteids soluble in cold water, 3.32 per cent; nonproteid organic extractives, 2.22 per cent; fats, 5.32 per cent, and ash, 1.25 per cent.

Offer and Rosenquist<sup>c</sup> studied the proportions of total nitrogen, nitrogen of extractives, and nitrogen of meat bases in fish and different kinds of raw, cooked, and preserved meat, in connection with an investigation of the comparative value of white and red meat in invalid dietetics. This work is referred to in more detail elsewhere (p. 142).

From a comparison of the data referred to above and those included in the present bulletin it seems fair to conclude that the modified

<sup>a</sup> U. S. Dept. Agr., Bureau of Chemistry Bul. 53.

<sup>b</sup> Rev. Hyg. et Pol. Sanit., 19 (1897), p. 394.

<sup>c</sup> Berlin. Klin. Wchnschr., 36 (1899), pp. 937, 968, 1086.

methods of analysis of meat which have been used in the investigation here reported give considerably more knowledge regarding the chemical composition of meats than has been gained by these earlier analyses. Furthermore, they make it possible to compare in detail the chemical composition of the same meats before and after cooking, so that information regarding the chemical changes which occur in the different processes of cooking has thus been obtained. The methods which have been used in this work are referred to in some detail on preceding pages (p. 12) and have been more fully described in another publication.<sup>a</sup> The methods have been very thoroughly tested, and the authors are convinced that they give as accurate and reliable results as the methods commonly used for the analysis of foods, if, indeed, they do not surpass them.

For the sake of a more ready comparison of the results here obtained and those of a number of the previous investigations described above, a table summarizing such data is given herewith:

TABLE 97.—*Summary of analyses showing forms of proteids and the organic extractives of meat.*

Kind of meat.	Number of analyses.	Water.	Proteid.			Organic extractives.			Fat.	Ash.
			Insoluble.	Soluble.	Total.	Nitrogenous.	Non nitrogenous.	Total.		
Mutton (fresh), Hennesberg and associates.	14	<i>Per ct.</i> 79.22	<i>Per ct.</i> 15.79	<i>Per ct.</i> 1.61	<i>Per ct.</i> 17.40	<i>Per ct.</i> .....	<i>Per ct.</i> .....	<i>Per ct.</i> 2.18	<i>Per ct.</i> 0	<i>Per ct.</i> 1.21
Fish (fresh), Atwater and associates .....	24	75.52	14.45	1.55	16.00	.....	.....	1.95	5.13	1.33
Fish (cured), Atwater and associates .....	7	50.53	18.87	.61	19.48	.....	.....	3.66	9.75	15.87
Fish (fresh), Almen ..	8	73.14	13.16	2.48	15.64	.....	.....	1.93	8.48	1.40
Fish (salted), Almen ..	5	50.01	17.06	1.46	18.52	.....	.....	3.56	10.97	16.86
Pork (fresh air-dried), Wiley and associates.	88	36.43	9.22	.....	9.22	1.14	.....	.....	49.67	2.11
Beef (fresh), Gautier ..	1	74.75	15.50	3.06	18.56	.....	.....	3.59	1.97	1.09
Mutton (fresh), Gautier.	1	74.92	13.66	3.32	16.98	.....	.....	2.22	5.32	1.25
Beef (fresh), Grindley and associates .....	12	69.13	15.52	2.29	17.81	1.08	1.62	2.70	10.95	1.03
Veal (fresh), Grindley and associates .....	2	75.75	16.23	2.37	18.60	1.17	1.66	2.83	2.48	1.13

The data presented in the above table show that fresh flesh from beef, veal, pork, mutton, and fish contains from 1.55 per cent to 3.32 per cent of soluble proteid matter coagulable by heat. The results obtained by the different investigators agree quite closely.

There has been no attempt, except in the first of the investigations here reported, to distinguish between the nitrogenous and the non-nitrogenous organic extractives. The results summarized indicate, however, that fresh flesh from the various sources given above contains from 1.93 per cent to 3.59 per cent of total organic extractives. It must be remembered in this connection that the methods used in determining the extractives by the different investigators mentioned

<sup>a</sup> Jour. Amer. Chem. Soc., 27 (1905), p. 658.

above are not similar, and this may, in part, account for the slight variations which appear.

The following tables (Nos. 98 and 99) give the analyses of all the uncooked meats used in connection with the cooking experiments here reported, the kinds and cuts of meat being plainly indicated. In each case figures are given for the composition of the fresh substance and for the same material calculated to a water-free basis:

TABLE 98.—*Chemical composition of uncooked meats (fresh substance).*

Laboratory No.	Cooking experiment No.	Kind of meat.	Water.	Proteid.			Organic extractives.		
				Insoluble.	Soluble.	Total.	Nitrogenous.	Non-nitrogenous.	Total.
			<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1672	122	Beef, flank .....	59.17	12.75	1.21	13.96	0.77	0.96	1.73
1668	121	Beef, neck .....	71.29	15.45	2.30	17.75	.81	1.63	2.44
1637	107	Beef, round .....	75.53	16.25	2.76	19.01	1.08	2.22	3.30
1640	108-109	.....do .....	74.04	16.86	2.77	19.63	1.37	1.72	3.09
1647	110-113	.....do .....	74.18	16.29	1.82	18.11	1.41	1.95	3.36
1722	131-132	.....do .....	72.57	16.26	2.70	18.96	1.12	1.99	3.11
1741	133-136	.....do .....	72.46	16.11	2.80	18.91	1.24	1.78	3.02
1753	137-140	.....do .....	73.65	16.84	2.39	19.23	1.11	1.52	2.63
1764	141-147	.....do .....	69.92	15.26	2.70	17.96	1.18	1.73	2.91
1775	150-156	.....do .....	73.28	16.47	2.20	18.67	1.13	1.40	2.53
		Average Nos. 1637, 1640, 1647, 1722, 1741, 1753, 1764, and 1775 .....	73.20	16.29	2.52	18.81	1.21	1.79	3.00
1676	123-124	Beef, rump .....	52.26	12.15	1.54	13.69	.66	.88	1.54
1705	125-126	.....do .....	61.22	.....	.....	17.71	.....	.....	.....
		Average for all beef .....	69.13	15.52	2.29	17.81	1.08	1.62	2.70
1656	114-116	Veal, leg .....	75.97	16.34	2.83	19.17	1.26	1.94	3.20
1662	117-120	.....do .....	75.53	16.12	1.90	18.02	1.08	1.37	2.45
		Average Nos. 1656 and 1662 .....	75.75	16.23	2.37	18.60	1.17	1.66	2.83

Laboratory No.	Cooking experiment No.	Kind of meat.	Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Non-proteid nitrogen.	Ratio of non-proteid to proteid nitrogen.
			<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	
1672	122	Beef, flank .....	24.95	0.71	100.52	2.479	2.233	0.246	1: 9.1
1668	121	Beef, neck .....	8.77	1.02	101.27	3.098	2.840	.258	1:11.0
1637	107	Beef, round .....	.....	1.19	.....	3.390	3.042	.348	1: 8.7
1640	108-109	.....do .....	3.19	1.18	101.13	3.580	3.140	.440	1: 7.1
1647	110-113	.....do .....	4.28	1.28	101.21	3.350	2.898	.452	1: 6.4
1722	131-132	.....do .....	4.78	1.09	100.51	3.392	3.033	.359	1: 8.4
1741	133-136	.....do .....	4.52	1.06	99.97	3.424	3.026	.398	1: 7.6
1753	137-140	.....do .....	4.24	1.07	100.82	3.433	3.077	.356	1: 8.6
1764	141-147	.....do .....	8.15	1.06	100.00	3.251	2.873	.378	1: 7.6
1775	150-156	.....do .....	4.91	1.09	100.48	3.349	2.987	.362	1: 8.3
		Average Nos. 1637, 1640, 1647, 1722, 1741, 1753, 1764, and 1775 .....	4.87	1.13	100.59	3.396	3.009	.387	1: 8.0
1676	123-124	Beef, rump .....	32.38	.74	100.61	2.400	2.190	.210	1:10.4
1705	125-126	.....do .....	20.23	.91	100.07	2.834	.....	.....	.....
		Average for all beef .....	10.95	1.03	100.65	3.195	2.849	.346	1: 8.3
1656	114-116	Veal, leg .....	.96	1.15	100.45	3.470	3.067	.403	1: 7.6
1662	117-120	.....do .....	3.99	1.10	101.09	3.230	2.883	.347	1: 8.3
		Average Nos. 1656 and 1662 .....	2.48	1.13	100.77	3.350	2.975	.375	1: 8.0

a Not included in the average.

TABLE 99.—*Chemical composition of uncooked meats (water-free basis).*

Laboratory No.	Cooking experiment No.	Kind of meat.	Proteid.			Organic extractives.		
			Insoluble.	Soluble.	Total.	Nitrogenous.	Non-nitrogenous.	Total.
			<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1672	122	Beef, flank.....	31.20	2.99	34.19	1.89	2.35	4.24
1668	121	Beef, neck.....	53.81	8.02	61.83	2.82	5.68	8.50
1637	107	Beef, round.....	66.41	11.27	77.68	4.41	9.07	13.48
1640	108-109	.....do.....	64.94	10.68	75.62	5.28	6.62	11.90
1647	110-113	.....do.....	63.09	7.05	70.14	5.46	7.55	13.01
1722	131-132	.....do.....	59.26	9.86	69.12	4.08	7.25	11.33
1741	133-136	.....do.....	58.51	10.15	68.66	4.50	6.46	10.96
1753	137-140	.....do.....	63.89	9.09	72.98	4.21	5.77	9.98
1764	141-147	.....do.....	50.71	9.00	59.71	3.92	5.75	9.67
1775	150-156	.....do.....	61.64	8.23	69.87	4.23	5.24	9.47
		Average Nos. 1637, 1640, 1647, 1722, 1741, 1753, 1764, and 1775.....	61.05	9.42	70.47	4.51	6.71	11.22
1676	123-124	Beef, rump.....	25.45	3.23	28.68	1.38	1.84	3.22
1705	125-126	.....do.....	a 25.45		69.69			
		Average of all beef.....	54.45	8.14	62.59	3.83	5.78	9.61
1656	114-116	Veal, leg.....	67.99	11.78	79.77	5.24	8.07	13.31
1662	117-120	.....do.....	65.88	7.76	73.64	4.41	5.60	10.01
		Average Nos. 1656 and 1662 ..	66.94	9.77	76.71	4.83	6.84	11.67

Laboratory No.	Cooking experiment No.	Kind of meat.	Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Non-proteid nitrogen.
			<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1672	122	Beef, flank.....	61.11	1.74	101.28	6.071	5.469	0.602
1668	121	Beef, neck.....	30.55	3.55	104.43	10.791	9.892	0.899
1637	107	Beef, round.....		4.86		13.854	12.431	1.423
1640	108-109	.....do.....	12.29	4.55	104.36	13.791	12.099	1.692
1647	110-113	.....do.....	16.58	4.96	104.69	12.979	11.222	1.757
1722	131-132	.....do.....	17.43	3.97	101.85	12.366	11.059	1.307
1741	133-136	.....do.....	16.41	3.85	99.88	12.433	10.986	1.447
1753	137-140	.....do.....	16.09	4.06	103.11	13.028	11.677	1.351
1764	141-147	.....do.....	27.09	3.52	99.99	10.808	9.554	1.254
1775	150-156	.....do.....	18.38	4.08	101.80	12.534	11.179	1.355
		Average Nos. 1637, 1640, 1647, 1722, 1741, 1753, 1764, and 1775.....	17.75	4.23	102.25	12.724	11.276	1.448
1676	123-124	Beef, rump.....	67.83	1.55	101.28	5.027	4.589	.438
1705	125-126	.....do.....	a 52.16	2.35	a 100.20	a 7.308		
		Average of all beef.....	28.38	3.59	102.27	11.244	10.014	1.230
1656	114-116	Veal, leg.....	3.99	4.79	101.86	14.440	12.763	1.677
1662	117-120	.....do.....	16.31	4.50	104.46	13.200	11.782	1.418
		Average Nos. 1656 and 1662 ..	10.15	4.65	103.16	13.820	12.273	1.547

a Not included in the average.

These analyses apparently teach us nothing essentially new regarding the water, fat, and ash contents of meat, but they do increase our knowledge of the nitrogen-free organic extractives and the nitrogenous constituents, including both the proteid and the nitrogenous organic extractives.

By referring to Table 98, page 99, it will be seen that the average results here obtained for 12 samples of fresh beef flesh were as follows: Water 69.13 per cent, insoluble proteid 15.52 per cent, soluble

proteid 2.29 per cent, total proteid 17.81 per cent, nitrogenous organic extractives 1.08 per cent, nonnitrogenous organic extractives 1.62 per cent, total organic extractives 2.70 per cent, fat 10.95 per cent, and ash 1.03 per cent. The average amount of nitrogen in different forms for the same samples was: Total nitrogen 3.195 per cent, proteid nitrogen 2.849 per cent, and nonproteid nitrogen 0.346 per cent. The ratio of the nonproteid to proteid nitrogen was 1:8.3. The average results obtained in the analysis of 2 samples of fresh veal were: Water 75.75 per cent, insoluble proteid 16.23 per cent, soluble proteid 2.37 per cent, total proteid 18.60 per cent, nitrogenous organic extractives 1.17 per cent, nonnitrogenous organic extractives 1.66 per cent, total organic extractives 2.83 per cent, fat 2.48 per cent, and ash 1.13 per cent. The average values for nitrogen were: Total nitrogen 3.350 per cent, proteid nitrogen 2.975 per cent, and nonproteid nitrogen, 0.375 per cent. The ratio of the nonproteid to proteid nitrogen was 1:8.

It will be seen that the soluble proteid in uncooked meat forms, approximately, 12.80 per cent, or about one-eighth, of the total proteid. The nonnitrogenous extractives are in all cases somewhat more abundant than are the nitrogenous extractives. In general, the soluble albumin and the nitrogenous and nonnitrogenous extractives vary inversely with the fat; that is to say, the meats which contain the most fat have, as a rule, the lower percentage of soluble albumin and organic extractives, and vice versa. However, the amount of extractives in corresponding cuts of meat from different animals may vary considerably even when the fat content is about the same. For example, lean beef round (sample No. 1775), containing 4.91 per cent of fat, has only 2.53 per cent of organic extractives, while lean beef round (sample No. 1647) contains 4.28 per cent of fat and has 3.36 of organic extractives.

The usual method of calculating the percentage of proteid in meats by multiplying the total nitrogen by the factor 6.25 evidently gives a much higher figure for the true proteids than should be assigned to them. For example, if the average total nitrogen (3.195 per cent) found in the twelve samples of fresh beef is multiplied by the factor 6.25, the product obtained is 19.97 per cent. The proteid obtained by actual analysis with the methods used in this investigation is only 17.81 per cent, or a difference of 2.16 per cent. The discrepancy is due to the fact that the former value includes organic extractives. Since the nutritive value of the organic extractives is certainly much less than that of the proteids, the usual method must necessarily lead to errors in the determination of the nutritive value of meats and meat products.



## COMPOSITION OF MEATS COOKED BY BOILING.

So little work having to do with the influence of cooking upon the composition of meats has been found that it seems unnecessary to take it into consideration in discussing the results presented in connection with the present investigation.

The following tables (Nos. 100 and 101) summarize the data regarding the composition of the boiled meat, that is, meat cooked in hot water, this method of cooking being, as before explained, for convenience designated boiling, whatever the temperature of the water. The results are calculated, as before, to the fresh and to the water-free basis:

TABLE 100.—*Chemical composition of meats cooked by boiling (fresh substance).*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Water.	Proteid.		
				At beginning.	During cooking.			Insoluble.	Soluble.	Total.
				°C.	°C.	Hrs.	Per ct.	Per ct.	Per ct.	Per ct.
1642	1640	109	Beef, round.....	Cold.	85	3	59.91	35.07	0.13	35.20
1754	1753	137	.....do.....	Cold.	85	3	56.24	35.01	.20	35.21
			Average.....				58.08	35.04	.17	35.21
1756	1753	139	Beef, round (browned)	Cold.	85	3	57.22	32.67	.17	32.84
			Average Nos. 1642, 1754, and 1756.....				57.79	34.25	.17	34.42
1746	1741	136	Beef, round (browned)	85	85	3	56.50	33.98	.15	34.13
1769	1764	145	Beef, round.....	85	85	3	56.49	34.20	.21	34.41
1780	1775	154	.....do.....	85	85	3	55.19	36.02	.13	36.15
			Average Nos. 1769 and 1780.....				55.84	35.11	.17	35.28
			Average Nos. 1746, 1769, and 1780.....				56.06	34.74	.16	34.90
1641	1640	108	Beef, round.....	100	85	3	59.01	35.89	.38	36.27
1744	1741	134	.....do.....	100	85	3	57.88	34.72	.33	35.05
1768	1764	144	.....do.....	100	85	3	58.81	30.98	.21	31.19
1779	1775	153	.....do.....	100	85	3	54.17	35.51	.20	35.71
			Average.....				57.47	34.28	.28	34.56
1755	1753	138	Beef, round.....	Cold.	100	3	56.20	34.67	.44	35.11
1757	1753	140	Beef, round (browned)	Cold.	100	3	56.45	34.52	.49	35.01
			Average.....				56.33	34.59	.47	35.06
1743	1741	133	Beef, round.....	100	100	3	57.65	34.59	.33	34.92
1745	1741	135	Beef, round (browned)	100	100	3	57.19	33.04	.24	33.28
			Average.....				57.42	33.81	.29	34.10
			Average of all cooked 3 hours.....				57.07	34.35	.26	34.61
1646	1647	113	Beef, round.....	Cold.	65	5	62.93	31.89	.27	32.16
1645	1647	112	.....do.....	Cold.	85	5	59.84	32.87	.36	33.23
1654	1656	116	Veal, leg.....	Cold.	85	5	68.59	30.50	.60	31.10
1658	1662	118	.....do.....	Cold.	85	5	64.66	28.82	.31	29.13
			Average Nos. 1654 and 1658.....				66.63	29.66	.46	30.12
			Average Nos. 1645, 1654, and 1658.....				64.36	30.73	.42	31.15



TABLE 100.—*Chemical composition of meats cooked by boiling (fresh substance)*—Cont'd.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Water.	Proteid.		
				At beginning.	During cooking.			Insoluble.	Soluble.	Total.
				°C.	°C.	Hrs.	Per ct.	Per ct.	Per ct.	Per ct.
1644	1647	111	Beef, round.....	100	85	5	59.12	33.85	0.29	34.14
1720	1722	131	.....do.....	100	85	5	55.31	31.72	.16	31.88
			Average.....				57.22	32.78	.23	33.01
1665	1668	121	Beef, neck.....	100	85	5	54.40	30.67	.19	30.86
1673	1676	123	Beef, rump.....	100	85	5	38.35	18.96	.38	19.34
1703	1705	125	.....do.....	100	85	5	48.34	26.75	.38	27.13
			Average Nos. 1673 and 1703.....				43.35	22.86	.38	23.24
1669	1672	122	Beef, flank.....	100	85	5	46.46	19.59	.39	19.98
1653	1656	115	Veal, leg.....	100	85	5	66.65	31.62	.49	32.11
1664	1662	117	.....do.....	100	85	5	61.87	29.21	.32	29.53
			Average Nos. 1653 and 1664.....				64.26	30.41	.41	30.82
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....				53.82	27.80	.33	28.12
1639	1637	107	Beef, round.....	100	100	5	59.68	33.32	.97	34.29
1643	1647	110	.....do.....	100	100	5	60.52	31.76	.92	32.68
1721	1722	132	.....do.....	100	100	5	57.12	31.42	.56	31.98
			Average.....				59.11	32.16	.82	32.98
1704	1705	126	Beef, rump.....	100	100	5	55.01	26.68	.90	27.58
1652	1656	114	Veal, leg.....	100	100	5	64.73	30.51	.44	30.95
			Average Nos. 1639, 1643, 1652, 1704, and 1721.....				59.41	30.73	.76	31.49
			Average of all cooked 5 hours.....				57.86	29.41	.47	29.88
			Average of all cooked 3 and 5 hours.....				57.50	31.57	.38	31.95

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Organic extractives.			Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Nonproteid nitrogen.	Ratio of nonproteid to proteid nitrogen.
				Nitrogenous.	Nonnitrogenous.	Total.							
1642	1640	109	Beef, round.....	P. ct. 0.43	P. ct. 0.56	P. ct. 0.99	P. ct. 3.93	P. ct. 0.51	P. ct. 100.54	P. ct. 5.770	P. ct. 5.632	0.138	1:40.8
1754	1753	137	.....do.....	.78	.82	1.60	6.80	.70	100.55	5.884	5.634	.250	1:22.5
			Average.....	.61	.69	1.30	5.37	.61	100.55	5.827	5.633	.194	1:31.7
1756	1753	139	Beef, round (browned)	.75	.75	1.50	8.00	.67	100.23	5.495	5.255	.240	1:21.9
			Average Nos. 1642, 1754, and 1756.....	.65	.71	1.36	6.24	.63	100.44	5.716	5.507	.209	1:26.3
1746	1741	136	Beef, round (browned)	.73	.91	1.64	7.12	.70	100.09	5.696	5.461	.235	1:23.2
1769	1764	145	Beef, round.....	.95	.88	1.83	6.87	.91	100.51	5.810	5.505	.305	1:18.0
1780	1775	154	.....do.....	.80	.92	1.72	6.62	.85	100.53	6.040	5.784	.256	1:22.6
			Average Nos. 1769 and 1780.....	.88	.90	1.78	6.75	.88	100.52	5.925	5.645	.280	1:20.3
			Average Nos. 1746, 1769, and 1780.....	.83	.90	1.73	6.87	.82	100.38	5.849	5.583	.266	1:21.0

TABLE 100.—*Chemical composition of meats cooked by boiling (fresh substance)*—Cont'd.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Organic extractives.			Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Nonproteid nitrogen.	Ratio of nonproteid to proteid nitrogen.
				Nitrogenous.	Nonnitrogenous.	Total.							
1641	1640	108	Beef, round.....	P. ct. 0.33	P. ct. 0.45	P. ct. 0.78	P. ct. 4.38	P. ct. 0.50	P. ct. 100.94	P. ct. 5.910	P. ct. 5.803	P. ct. 0.107	1:54.2
1744	1741	134	.....do.....	.79	1.08	1.87	4.83	.73	100.36	5.862	5.608	.254	1:22.1
1768	1764	144	.....do.....	.99	1.28	2.27	7.51	.89	100.67	5.809	4.991	.318	1:15.7
1779	1775	153	.....do.....	.94	1.04	1.98	7.88	.84	100.58	6.013	5.713	.300	1:19.0
			Average.....	.76	.96	1.72	6.15	.74	100.64	5.774	5.529	.245	1:22.6
1755	1753	138	Beef, round.....	.74	.90	1.64	7.35	.71	101.01	5.857	5.618	.239	1:23.5
1757	1753	140	Beef, round (browned)	.79	.91	1.70	6.83	.70	100.69	5.855	5.602	.253	1:22.1
			Average.....	.77	.91	1.67	7.09	.71	100.85	5.856	5.610	.246	1:22.8
1743	1741	133	Beef, round.....	.77	1.04	1.81	5.06	.74	100.18	5.834	5.587	.247	1:22.6
1745	1741	135	Beef, round (browned)	.72	.79	1.51	7.74	.73	100.45	5.556	5.325	.231	1:23.1
			Average.....	.75	.92	1.67	6.40	.74	100.32	5.695	5.456	.239	1:22.8
			Average of all cooked 3 hours.	.75	.88	1.63	6.49	.73	100.53	5.778	5.537	.241	1:23.0
1646	1647	113	Beef, round.....	.29	.38	.67	5.57	.55	101.88	5.240	5.146	.094	1:54.7
1645	1647	112	.....do.....	.32	.43	.75	5.23	.54	99.59	5.420	5.317	.103	1:51.6
1654	1656	116	Veal, leg.....	.29	.96	1.25	.97	.64	102.55	5.070	4.976	.094	1:52.9
1658	1662	118	.....do.....	.44	.55	.99	5.58	.59	100.95	4.800	4.660	.140	1:33.3
			Average Nos. 1654 and 1658	.37	.76	1.13	3.28	.62	101.75	4.935	4.818	.117	1:41.2
			Average Nos. 1645, 1654, and 1658.	.35	.65	1.00	3.93	.59	101.03	5.096	4.984	.112	1:44.5
1644	1647	111	Beef, round.....	.40	.57	.97	5.75	.69	100.67	5.590	5.462	.128	1:42.7
1720	1722	131	.....do.....	.65	.15	.80	11.61	.51	100.11	5.309	5.100	.209	1:24.4
			Average.....	.53	.36	.89	8.68	.60	100.39	5.450	5.281	.169	1:31.2
1665	1668	121	Beef, neck.....	.32	.55	.87	13.68	.47	100.28	5.039	4.937	.102	1:48.4
1673	1676	123	Beef, rump.....	.47	.43	.90	42.03	.33	100.95	3.245	3.094	.151	1:20.5
1703	1705	125	.....do.....	.29	.34	.63	23.36	.43	99.89	4.433	4.340	.093	1:46.7
			Average Nos. 1673 and 1703	.38	.39	.77	32.70	.38	100.42	3.839	3.717	.122	1:30.5
1669	1672	122	Beef, flank.....	.04	.17	.21	34.16	.24	101.05	3.210	3.196	.014	1:23.3
1653	1656	115	Veal, leg.....	.69	1.00	1.69	1.31	.75	102.51	5.360	5.138	.222	1:23.1
1664	1662	117	.....do.....	.56	.76	1.32	7.77	.66	101.15	4.900	4.724	.176	1:26.8
			Average Nos. 1653 and 1664	.63	.88	1.51	4.54	.71	101.83	5.130	4.931	.199	1:24.8
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720	.43	.50	.93	17.46	.51	100.83	4.636	4.499	.137	1:32.8
1639	1637	107	Beef, round.....	.48	1.19	1.67	.....	.79	.....	5.640	5.486	.154	1:35.6
1643	1647	110	.....do.....	.44	.57	1.01	5.66	.74	100.61	5.370	5.229	.141	1:37.1
1721	1722	132	.....do.....	.65	.50	1.15	9.01	.63	99.89	5.324	5.116	.208	1:24.6
			Average.....	.52	.75	1.27	7.34	.72	100.25	5.445	5.277	.168	1:31.4
1704	1705	126	Beef, rump.....	.53	.72	1.25	16.07	.68	100.59	4.583	4.413	.170	1:26.0
1652	1656	114	Veal, leg.....	1.12	1.67	2.79	1.59	1.01	101.17	5.310	4.952	.358	1:13.8
			Average Nos. 1639, 1643, 1652, 1704, and 1721	.64	.93	1.57	8.09	.77	100.57	5.246	5.039	.207	1:24.3
			Average of all cooked 5 hours.	.47	.65	1.12	11.84	.60	100.87	4.932	4.782	.150	1:31.9
			Average of all cooked 3 and 5 hours.....	.60	.75	1.35	9.34	.66	100.71	5.314	5.123	.191	1:26.8

TABLE 101.—*Chemical composition of meats cooked by boiling (calculated to water-free basis).*

Laboratory No.	Raw meat used, No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Proteid.		
				At beginning.	During cooking.		Insoluble.	Soluble.	Total.
1642	1640	109	Beef, round.....	°C. Cold.	°C. 85	Hrs. 3	Per ct. 87.45	Per ct. 0.35	Per ct. 87.80
1754	1753	137	.....do .....	Cold.	85	3	80.00	.46	80.46
			Average .....				83.73	.40	84.13
1756	1753	139	Beef, round (browned) ..	Cold.	85	3	76.36	.40	76.76
			Average Nos. 1642, 1754, and 1756.....				81.27	.40	81.67
1746	1741	136	Beef, round (browned) ..	85	85	3	78.11	.35	78.46
1769	1764	145	Beef, round.....	85	85	3	78.59	.50	79.09
1780	1775	154	.....do .....	85	85	3	80.38	.29	80.67
			Average Nos. 1769 and 1780 .....				79.48	.40	79.88
			Average Nos. 1746, 1769, and 1780.....				79.03	.38	79.41
1641	1640	108	Beef, round.....	100	85	3	87.55	.93	88.48
1744	1741	134	.....do .....	100	85	3	82.43	.78	83.21
1768	1764	144	.....do .....	100	85	3	75.21	.51	75.72
1779	1775	153	.....do .....	100	85	3	77.48	.44	77.92
			Average .....				80.66	.67	81.33
1755	1753	138	Beef, round.....	Cold.	100	3	79.16	1.00	80.16
1757	1753	140	Beef, round (browned) ..	Cold.	100	3	79.26	1.13	80.39
			Average .....				79.21	1.07	80.28
1743	1741	133	Beef, round.....	100	100	3	81.67	.78	82.45
1745	1741	135	Beef, round (browned) ..	100	100	3	77.17	.57	77.74
			Average .....				79.42	.68	80.10
			Average of all cooked 3 hours.....				80.06	.61	80.67
1646	1647	113	Beef, round.....	Cold.	65	5	86.03	.73	86.76
1645	1647	112	.....do .....	Cold.	85	5	81.85	.89	82.74
1654	1656	116	Veal, leg .....	Cold.	85	5	97.12	1.89	99.01
1658	1662	118	.....do .....	Cold.	85	5	81.52	.91	82.43
			Average Nos. 1654 and 1658 .....				89.32	1.40	90.72
			Average Nos. 1645, 1654, and 1658.....				86.83	1.23	88.06
1644	1647	111	Beef, round .....	100	85	5	82.80	.71	83.51
1720	1722	131	.....do .....	100	85	5	70.98	.36	71.34
			Average .....				76.89	.54	77.43
1665	1668	121	Beef, neck.....	100	85	5	67.26	.42	67.68
1673	1676	123	Beef, rump .....	100	85	5	30.75	.62	31.37
1703	1705	125	.....do .....	100	85	5	51.78	.74	52.52
			Average Nos. 1673 and 1703.....				41.27	.68	41.95
1669	1672	122	Beef, flank.....	100	85	5	36.57	.75	37.32
1653	1656	115	Veal, leg .....	100	85	5	94.81	1.47	96.28
1664	1662	117	.....do .....	100	85	5	76.61	.84	77.45
			Average Nos. 1653 and 1664.....				85.71	1.16	86.87
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....				63.94	.74	64.68

TABLE 101.—*Chemical composition of meats cooked by boiling (calculated to water-free basis)*—Continued.

Laboratory No.	Raw meat used, No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Proteid.		
				At begin-ning.	During cook- ing.		Insol- ible.	Soluble.	Total.
				°C.	°C.	Hrs.	Per ct.	Per ct.	Per ct.
1639	1637	107	Beef, round .....	100	100	5	82.64	2.40	85.04
1643	1647	110	.....do .....	100	100	5	80.45	2.33	82.78
1721	1722	132	.....do .....	100	100	5	73.27	1.31	74.58
			Average .....				78.79	2.01	80.80
1704	1705	126	Beef, rump .....	100	100	5	59.30	2.00	61.30
1652	1656	114	Veal, leg .....	100	100	5	86.50	1.25	87.75
			Average Nos. 1639, 1643, 1652, 1704, and 1721 .....				76.43	1.86	78.29
			Average of all cooked 5 hours ..				72.95	1.16	74.11
			Average of all cooked 3 and 5 hours .....				76.19	.88	77.07

Laboratory No.	Raw meat used, No.	Cooking experiment No.	Kind of meat.	Organic extractives.			Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Nonproteid nitro- gen.
				Nitroge- nous.	Nonitroge- nous.	Total.						
1642	1640	109	Beef, round .....	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
1754	1753	137	.....do .....	1.07	1.40	2.47	9.80	1.27	101.34	14.393	14.048	0.345
			Average .....	1.78	1.87	3.65	15.54	1.60	101.25	13.446	12.873	.573
			Average .....	1.42	1.64	3.06	12.67	1.44	101.30	13.920	13.461	.459
1756	1753	139	Beef, round (browned) ..	1.75	1.75	3.50	18.70	1.57	100.53	12.845	12.282	.563
			Average Nos. 1642, 1754, and 1756 .....	1.53	1.67	3.20	14.68	1.48	101.04	13.561	13.068	.494
1746	1741	136	Beef, round (browned) ..	1.68	2.09	3.77	16.37	1.61	100.21	13.094	12.554	.540
1769	1764	145	Beef, round .....	2.18	2.02	4.20	15.79	2.09	101.17	13.353	12.654	.699
1780	1775	154	.....do .....	1.79	2.05	3.84	14.77	1.90	101.18	13.479	12.907	.572
			Average Nos. 1769 and 1780 .....	1.99	2.04	4.03	15.28	2.00	101.18	13.416	12.781	.636
			Average Nos. 1746, 1769, and 1780 .....	1.88	2.05	3.93	15.64	1.87	100.85	13.309	12.705	.604
1641	1640	108	Beef, round .....	.81	1.10	1.91	10.69	1.22	102.30	14.418	14.157	.261
1744	1741	134	.....do .....	1.88	2.56	4.44	11.47	1.73	100.85	13.917	13.314	.603
1768	1764	144	.....do .....	2.40	3.11	5.51	18.23	2.16	101.62	12.889	12.115	.774
1779	1775	153	.....do .....	2.05	2.27	4.32	17.19	1.84	101.27	13.120	12.467	.653
			Average .....	1.79	2.26	4.05	14.40	1.74	101.51	13.586	13.013	.573
1755	1753	138	Beef, round .....	1.69	2.06	3.75	16.78	1.62	102.31	13.372	12.826	.546
1757	1753	140	Beef, round (browned) ..	1.81	2.09	3.90	15.68	1.61	101.58	13.444	12.862	.582
			Average .....	1.75	2.08	3.83	16.23	1.62	101.95	13.408	12.844	.564
1743	1741	133	Beef, round .....	1.82	2.46	4.28	11.95	1.75	100.43	13.776	13.192	.584
1745	1741	135	Beef, round (browned) ..	1.68	1.85	3.53	18.06	1.71	101.06	12.978	12.438	.540
			Average .....	1.75	2.16	3.91	15.02	1.73	100.75	13.377	12.815	.562
			Average of all cooked 3 hours ..	1.74	2.05	3.79	15.08	1.69	101.22	13.466	12.906	.560

TABLE 101.—*Chemical composition of meats cooked by boiling (calculated to water-free basis)*—Continued.

Laboratory No.	Raw meat used, No.	Cooking experiment No.	Kind of meat.	Organic extractives.			Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Nonproteid nitrogen.
				Nitrogenous.	Nonnitrogenous.	Total.						
1646	1647	113	Beef, round.....	0.78	1.03	1.81	15.03	1.48	105.08	14.135	13.882	0.253
1645	1647	112	.....do.....	.80	1.07	1.87	13.02	1.34	98.97	13.496	13.238	.258
1654	1656	116	Veal, leg.....	.92	3.06	3.98	3.09	2.04	108.12	16.140	15.842	.298
1658	1662	118	.....do.....	1.25	1.55	2.80	15.79	1.67	102.69	13.582	13.189	.393
			Average Nos. 1654 and 1658.....	1.06	2.31	3.37	9.44	1.86	105.41	14.861	14.516	.346
			Average Nos. 1645, 1654, and 1658....	.99	1.89	2.88	10.63	1.68	103.26	14.406	14.090	.316
1644	1647	111	Beef, round.....	.98	1.39	2.37	14.07	1.69	101.64	13.674	13.362	.312
1720	1722	131	.....do.....	1.45	.34	1.79	25.98	1.14	100.25	11.880	11.414	.466
			Average.....	1.22	.87	2.09	20.03	1.42	100.95	12.777	12.388	.389
1665	1668	121	Beef, neck.....	.70	1.21	1.91	30.00	1.03	100.62	11.049	10.829	.220
1673	1676	123	Beef, rump.....	.76	.70	1.46	68.18	.54	101.55	5.264	5.019	.245
1703	1705	125	.....do.....	.56	.66	1.22	45.22	.83	99.79	8.581	8.403	.178
			Average Nos. 1673 and 1703.....	.66	.68	1.34	56.70	.69	100.67	6.923	6.711	.212
1669	1672	122	Beef, flank.....	.07	.32	.39	63.80	.45	101.96	5.996	5.971	.025
1653	1656	115	Veal, leg.....	2.07	3.00	5.07	3.93	2.25	107.53	16.072	15.405	.667
1664	1662	117	.....do.....	1.47	1.99	3.46	20.38	1.73	103.02	12.851	12.392	.459
			Average Nos. 1653 and 1664.....	1.77	2.50	4.27	12.16	1.99	105.28	14.462	13.899	.563
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	1.01	1.20	2.21	33.95	1.21	102.05	10.671	10.349	.322
1639	1637	107	Beef, round.....	1.19	2.95	4.14	.....	1.96	.....	13.988	13.607	.381
1643	1647	110	.....do.....	1.12	1.44	2.56	14.34	1.87	101.55	13.602	13.245	.357
1721	1722	132	.....do.....	1.51	1.17	2.68	21.01	1.47	99.74	12.416	11.933	.483
			Average.....	1.27	1.85	3.12	17.68	1.77	100.65	13.335	12.928	.407
1704	1705	126	Beef, rump.....	1.18	1.60	2.78	35.72	1.51	101.31	10.190	9.808	.382
1652	1656	114	Veal, leg.....	3.18	4.74	7.92	4.51	2.86	103.04	15.055	14.040	1.015
			Average Nos. 1639, 1643, 1652, 1704, and 1721.....	1.64	2.38	4.02	18.90	1.94	101.41	13.050	12.526	.524
			Average of all cooked 5 hours..	1.18	1.66	2.84	24.63	1.52	102.25	12.234	11.857	.377
			Average of all cooked 3 and 5 hours.....	1.43	1.84	3.27	20.17	1.60	101.77	12.790	12.531	.459

It will be seen that the average results obtained from analysis of 31 samples of different cuts of beef and veal which had been cooked by boiling, under the various conditions indicated, were as follows: Water 57.50 per cent, insoluble proteid 31.57 per cent, soluble proteid 0.38 per cent, total proteid 31.95 per cent, nitrogenous extractives 0.60 per cent, nonnitrogenous extractives 0.75 per cent, total organic extractives 1.35 per cent, fat 9.34 per cent, ash 0.66 per cent, making a total of 100.71 per cent. The average nitrogen values for these samples of boiled meats were: Total nitrogen 5.314 per cent, proteid nitrogen



5.123 per cent, and nonproteinid nitrogen 0.191 per cent. The ratio of nonproteinid to proteinid nitrogen was 1:26.8.

If these results are compared with those obtained for the corresponding raw meats, it will be seen that there is a marked difference between the chemical composition of uncooked meats and meats cooked in hot water, the analysis of the 13 samples of the corresponding uncooked meats (beef and veal) being as follows: Water 70.08<sup>a</sup> per cent, insoluble proteinid 15.63 per cent, soluble proteinid 2.30 per cent, total proteinid 17.93 per cent, nitrogenous extractives 1.09 per cent, non-nitrogenous 1.63 per cent, total organic extractives 2.72 per cent, fat 9.65 per cent, ash 1.04 per cent, making a total of 100.67 per cent. The average nitrogen values for the uncooked meats were: Total nitrogen 3.219 per cent, proteinid nitrogen 2.868 per cent, and nonproteinid nitrogen, 0.351 per cent. The ratio of nonproteinid to proteinid nitrogen was 1:8.25.

It is evident that there is a decided decrease in water content of the meat when it is boiled in water. The average amount of water in the 14 samples of uncooked meats was 70.08 per cent, while in the 31 samples cooked in hot water it was only 57.50 per cent. This corresponds with results previously obtained in this laboratory, and all go to show that there is always a loss of water when meats are cooked in hot water. It follows from the above consideration that the cooked meats will contain a considerable higher percentage than the raw of some or all of the constituents other than water. This is especially true of the insoluble proteinid, which amounts to 31.57 per cent in the cooked meats and to only 15.63 per cent in the uncooked meats; that is to say, the percentage amount of insoluble proteinid in the cooked meats is slightly more than twice as great as in the raw meats. It must not, however, be supposed that this greater proportion of proteinid in the cooked meats is due entirely to the decrease in the proportion of water. Some of the increase is due to the coagulation of albumin during the process of cooking which renders some soluble proteinid insoluble.

Indeed, one of the most pronounced differences in the chemical composition of cooked and uncooked meats occurs in the amount of soluble albumin present. The average quantity of soluble proteinid in the 13 samples of raw meat was 2.30 per cent, and in the 31 samples of boiled meat only 0.38 per cent. In other words, during the cooking of the meat 1.92 per cent of the proteinid present in the uncooked meat in a soluble form was rendered insoluble by coagulation. The actual nature of this change will probably be better understood after a study of the water-free substances. In the water-free substance of the cooked meats there is 76.19 per cent of the insoluble proteinid, 0.88 per cent of soluble proteinid, and 77.07 per cent of total proteinid. On the other hand, the insoluble proteinid forms 56.37 per cent, the soluble

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<sup>a</sup> In the case of water the average represents 14 samples.



proteid 8.39 per cent, and the total proteid 64.76 per cent of the water-free substance of the uncooked meats.

This difference between the cooked and uncooked meat may be further illustrated by comparing the ratios of the soluble to the insoluble proteid. The ratio of the soluble proteid to the insoluble proteid in the case of the uncooked meats is 1:6.7, and in the case of the cooked meats is 1:86.8.

Another characteristic difference which is readily observed between the chemical composition of uncooked meats and meats cooked by boiling occurs in the quantities of organic extractives which they contain, both the nitrogen and the nonnitrogenous extractives being present in much smaller proportions in the freshly cooked meats than in the raw. The average values were, nitrogenous extractives 1.09 per cent, nonnitrogenous 1.63 per cent, and total organic extractives 2.72 per cent, in the 13 samples of uncooked meats (beef and veal). The analyses of the 31 samples of meats (beef and veal) cooked in hot water show that they contained the following: Nitrogenous extractives 0.60 per cent, nonnitrogenous extractives 0.75 per cent, and total organic extractives 1.35 per cent. If the figures are calculated to the water-free basis, they will be more strictly comparable. On this basis the uncooked meats contained upon an average 3.98 per cent of nitrogenous extractives, 5.94 per cent of nonnitrogenous extractives, and 9.93 per cent of total organic extractives, and the cooked meats contained 1.45 per cent of nitrogenous extractives, 1.84 per cent of nonnitrogenous extractives, and 3.27 per cent of total organic extractives. In other words, the boiled meats contained a little less than one-third as much of the organic extractives as the raw. Examination of the broths resulting in the cooking showed that somewhat more than two-thirds of these extractive constituents of the meat entered the broth during the contact of the meat with the water in which it was cooked.

The amount of fat contained in the fresh substance of the uncooked and cooked meats is about the same, the average for 13 samples of raw meats being 9.65 per cent, and for 31 samples of boiled meats 9.34 per cent. On a water-free basis the percentage of fat in the raw meats is 27.40 and in the cooked meats only 20.17. So it appears that during the cooking there is actually a loss of fat. This has also been demonstrated by analysis of the resulting broths, which are found to contain some of the meat fat.

The data presented show plainly that the ash content of meat cooked in hot water is much less than that of the same meat before cooking. The analyses of 13 samples of uncooked meats gave an average of 1.09 per cent of ash, and of 31 samples of boiled meats 0.66 per cent. Calculating these results to a water-free basis, the ash in the raw meats is 3.74 per cent and only 1.60 per cent in the cooked meats.

From what has been said regarding the proteid and nitrogenous organic extractives, it follows that the meat cooked by boiling would contain a considerably greater proportion of proteid nitrogen and a smaller proportion of nonproteid nitrogen than the raw. The boiled meat contained 5.123 per cent of proteid nitrogen and 0.191 per cent of nonproteid nitrogen, while the raw meats contained 2.868 per cent of proteid nitrogen and 0.351 per cent of nonproteid nitrogen. This difference in the relation between the amounts of proteid and nonproteid nitrogen in the boiled and the raw meats may be strikingly shown by calculating the ratio of the nonproteid to the proteid nitrogen in the two cases. Thus the ratio of the nonproteid to the proteid nitrogen in the cooked meats is 1:26.8, while in the uncooked meats it is 1:8.2

There is another especially interesting question connected with the results here presented, namely, What influences do slow and rapid cooking, low and high temperature, and other variations in the methods of cooking of meats in water have upon their chemical composition and nutritive value? In order that such differences, if they exist, may be more readily studied, a table has been prepared in which a summary of the average composition of meats cooked by different methods is given, together with the average composition of the 13 samples of raw meats:

TABLE 102.—*Summary showing the chemical composition of boiled and uncooked meats.*

Methods of cooking.	Temperature.		Duration of cooking.	Water.	Proteid.		
	At beginning.	During cooking.			Insoluble.	Soluble.	Total.
BOILED 3 HOURS.							
Experiments Nos. 109, 137, 139.....	°C. Cold.	°C. 85	Hours. 3	Per ct. 57.79	Per ct. 34.25	Per ct. 0.17	Per ct. 34.42
Experiments Nos. 136, 145, 154.....		85	3	56.06	34.74	.16	34.90
Experiments Nos. 108, 134, 144, 153.....		85	3	57.47	34.28	.28	34.56
Average of 10 tests (Nos. 108, 109, 134, 136, 137, 139, 144, 145, 153, 154) .....		85	3	57.14	34.41	.21	34.62
Experiments Nos. 138, 140.....	Cold.	100	3	56.33	34.59	.47	35.06
Experiments Nos. 133, 135.....	100	100	3	57.42	33.81	.29	34.10
Average of 4 tests (Nos. 133, 135, 138, 140) .....		100	3	56.87	34.20	.38	34.58
Average of above 14 tests.....			3	57.07	34.35	.26	34.61
BOILED 5 HOURS.							
Experiment No. 113.....	Cold.	65	5	62.93	31.89	.27	32.16
Experiments Nos. 112, 116, 118.....	Cold.	85	5	64.36	30.73	.42	31.15
Experiments Nos. 111, 115, 117, 121, 122, 123, 125, 131.....		85	5	53.82	27.79	.33	28.12
Average of 6 tests (Nos. 111, 118, 121, 123, 125, 131) .....		85	5	56.70	28.59	.36	28.95
Experiments Nos. 107, 110, 132, 126, 114.....		100	5	59.41	30.73	.76	31.49
Average of above 17 tests.....			5	57.86	29.41	.47	29.88
Average of above 31 tests with boiled meat.....				57.50	31.57	.38	31.95
RAW MEAT.							
Average of 13 tests .....				70.08	15.63	2.30	17.93

TABLE 102.—*Summary showing the chemical composition of boiled and uncooked meats—Continued.*

Method of cooking.	Organic extractives.			Fat.	Ash.	Total solid matter.	Total nitrogen.	Pro- teid nitrogen.	Non- pro- teid nitrogen.	Ratio of non- proteid to pro- teid nitrogen.
	Ni- troge- nous.	Non- ni- troge- nous.	To- tal.							
BOILED 3 HOURS.										
Experiments Nos. 109, 137, 139 ...	<i>P. ct.</i> 0.65	<i>P. ct.</i> 0.71	<i>P. ct.</i> 1.36	<i>P. ct.</i> 6.24	<i>P. ct.</i> 0.63	<i>P. ct.</i> 100.44	<i>P. ct.</i> 5.716	<i>P. ct.</i> 5.507	<i>P. ct.</i> 0.209	1:26.3
Experiments Nos. 136, 145, 154 ...	.83	.90	1.73	6.87	.82	100.38	5.849	5.583	.266	1:21.0
Experiments Nos. 108, 134, 144, 153.	.76	.96	1.72	6.15	.74	100.64	5.774	5.529	.245	1:22.6
Average of 10 tests (Nos. 108, 109, 134, 136, 137, 139, 144, 145, 153, 154) .....	.75	.87	1.62	6.39	.73	100.50	5.779	5.539	.240	1:23.1
Experiments Nos. 138, 140.....	.77	.91	1.68	7.09	.71	100.85	5.856	5.610	.246	1:22.8
Experiments Nos. 133, 135.....	.75	.92	1.67	6.40	.74	100.32	5.695	5.456	.239	1:22.8
Average of 4 tests (Nos. 133, 135, 138, 140) .....	.76	.92	1.68	6.75	.73	100.59	5.776	5.533	.243	1:22.8
Average of above 14 tests ..	.75	.88	1.63	6.49	.73	100.53	5.778	5.537	.241	1:23.0
BOILED 5 HOURS.										
Experiment No. 113.....	.29	.38	.67	5.57	.55	101.88	5.240	5.146	.094	1:54.7
Experiments Nos. 112, 116, 118....	.35	.65	1.00	3.93	.59	101.03	5.096	4.984	.112	1:44.5
Experiments Nos. 111, 115, 117, 121, 122, 123, 125, 131.....	.43	.50	.93	17.46	.51	100.83	4.636	4.499	.137	1:32.8
Average of 6 tests (Nos. 111, 118, 121, 123, 125, 131) .....	.41	.54	.95	13.77	.53	100.88	4.761	4.631	.130	1:35.6
Experiments Nos. 107, 110, 132, 126, 114.....	.64	.93	1.57	8.09	.77	100.57	5.246	5.039	.207	1:24.3
Average of above 17 tests ..	.47	.65	1.12	11.84	.60	100.87	4.932	4.782	.150	1:31.9
Average of above 31 tests with boiled meat.....	.60	.75	1.35	9.34	.66	100.71	5.314	5.123	.191	1:26.8
RAW MEAT.										
Average of 13 tests.....	1.09	1.63	2.72	9.65	1.04	100.67	3.219	2.868	.351	1: 8.2

Examination of the data presented in Table 102 makes it evident that the different methods of boiling do not produce differences in chemical composition which are nearly as marked as the differences between the chemical composition of boiled and raw meats. It is interesting in this connection to note the influence of the duration of the cooking period upon the composition of the meats. It is to be regretted that the work here reported does not contain results of cooking experiments in which similar portions from the same cut of meat had been used for cooking in boiling water for three hours and for five hours, respectively, so that strictly comparable results could be had. In the absence of such experiments, conclusions must be drawn from the average results of the experiments presented above in which different cuts of meats were used. The average composition of the fourteen samples of meats which were cooked for three hours was: Water 57.07 per cent, insoluble proteid 34.35 per cent, soluble proteid 0.26 per cent, total proteid 34.61 per cent, nitrogenous extractives 0.75 per cent, nonnitrogenous extractives 0.88 per cent, total organic extractives 1.63

per cent, fat 6.49 per cent, and ash 0.73 per cent. The average nitrogen values for the same meats were: Total nitrogen 5.778 per cent, proteid nitrogen 5.537 per cent, and nonproteid nitrogen 0.241 per cent, and the ratio of nonproteid nitrogen to proteid nitrogen was 1:23. The average composition of the seventeen samples of meats cooked for five hours was as follows: Water 57.86 per cent, insoluble proteid 29.41 per cent, soluble proteid 0.47 per cent, total proteid 29.88 per cent, nitrogenous extractives 0.47 per cent, nonnitrogenous extractives 0.65 per cent, total organic extractives 1.12 per cent, fat 11.84 per cent, and ash 0.60 per cent. The average nitrogen values were: Total nitrogen 4.932 per cent, proteid nitrogen 4.782 per cent, and nonproteid nitrogen 0.150 per cent, and the ratio of nonproteid to proteid nitrogen was 1:31.9.

It will be seen that the slight differences in the chemical composition of the meats cooked for three hours and those cooked for five hours are in part due to the greater proportion of fat in the meats cooked for the longer period. Were these average results calculated to the basis of fat-free and water-free substance, and so made strictly comparable with each other, the differences would be even smaller.

From the data here available, it appears that meats cooked in boiling water for five hours contain a somewhat higher amount of soluble proteids but a slightly smaller amount of other soluble materials—namely, nitrogenous extractives, nonnitrogenous extractives, total organic extractives, and ash—than do those cooked in hot water for only three hours. The ratio of nonproteid to proteid nitrogen indicates this fact. In the meats cooked for three hours this ratio is 1:23, while in the meats cooked for five hours it is 1:31.9.

In the next place it will be of interest to see what the data here presented indicate regarding the comparative chemical composition of meats cooked in water by different methods, the time being the same. Careful study in this laboratory has shown that when meat is cooked in water at 80 to 85° C., placing the meat in hot or cold water at the start has little effect on the amount of the nutrients of the meat which pass into the broth. It must be remembered that the meat used in the cooking experiments here reported was in the form of 1 to 2 inch cubes or else in pieces weighing from 1 to 2 pounds.

Referring to Table 102, page 110, it will be noted that in the first group of three experiments (Nos. 109, 137, and 139) the meat was first placed in cold water and the temperature so regulated that it took one hour for the water to reach 85° C. The meat was then cooked for three hours at that temperature. In the second group of three experiments (Nos. 136, 145, and 154) the meat was put directly into water having a temperature of 85° C. and cooked at that temperature for three hours. In the group of four experiments (Nos. 108, 134, 144, and 153) the meat was placed first in boiling water for ten minutes and the



temperature allowed to fall to  $85^{\circ}$  C., after which the cooking was continued at this temperature, the total time of cooking being three hours.

The table shows little difference in the chemical composition of the resulting cooked meats, the amount of water-soluble proteid, total proteid, and fat being practically the same in the three groups. The soluble proteid was slightly higher in the last group; that is, where the meat was first put into boiling water and then cooked at  $85^{\circ}$  C. The amounts of organic extractives, both nitrogenous and nonnitrogenous, were somewhat lower in the first group—that is, where the meat was first put into cold water—than in the other two groups. The difference, however, is not great, being only 0.37 per cent. The ash was also lower in the first group than in the other two and somewhat higher in the second group than in the third. Further, there was but little difference in the ratio of the nonproteid to the proteid nitrogen in the three groups. This is especially true in the second and third groups of experiments in which the ratio was 1:21 and 1:22.6, respectively. In the first group the ratio was 1:26.3.

Referring again to Table 102, page 110, the results are given of experiment No. 113, in which the meats were cooked for a period of five hours, the meat being placed in cold water at first, the temperature then being so adjusted that it took one hour for the water to reach  $65^{\circ}$  C., and cooking continued at this temperature. In the next group (experiments Nos. 112, 116, and 118) the meat was placed in water, cold at the start, and the temperature so regulated that it took one hour for the water to reach  $85^{\circ}$  C., at which temperature the meat was kept for five hours. In the third group (experiments Nos. 111, 115, 117, 121, 122, 123, 125, and 131) the meat was first placed in water near the boiling point for ten minutes, after which the temperature was allowed to drop to  $85^{\circ}$  C. and the cooking continued for a period covering five hours.

An examination of the results of these three groups of experiments reveals no marked difference in the chemical composition of the cooked meat due to the method of cooking. To be sure the average percentage of fat in the third group is much higher than it is in the first and second groups, but this is not due, however, to the method used in cooking the meat but to the character of the meat used. In consequence of this higher content of fat in this third group, it follows that the average proportion of water, protein, and other constituents for this group is correspondingly lower than for the other two groups. This fact should be kept in mind in considering the quantities of the soluble constituents in this series. The soluble proteid, the nitrogenous and the nonnitrogenous extractives, are again somewhat lower when the meat was put in cold water and then cooked at  $65^{\circ}$  C. than

they are in the two other groups. However, the differences are not great, the maximum difference in the total organic extractives being only 0.33 per cent. The percentage of ash is practically the same in the three groups, if the content of fat is taken into consideration. There is a greater difference in the ratio of the nonproteid to the proteid nitrogen than there was in the set of three experiments described immediately above, the ratio being 1:54.7 in the first group, 1:44.5 in the second, and 1:32.8 in the third group.

It seems fair to conclude that, everything considered, the results here presented show that only a very slight difference in the chemical composition of similar meats results when they are cooked by immersing them first in cold water and then in water at 85° C., or by placing them in boiling water and then continuing the cooking at 85° C. for five hours.

It is commonly supposed that when meat is plunged into boiling water the albumin coagulates and forms a crust which prevents the escape of nutritive materials into the broth. It is also believed that if a rich broth is desired, to be used either as a soup or with the meat as a stew, it is more desirable to place the meat in cold water at the start. From the results of these experiments, however, it is evident that under these conditions there can be little advantage in using either hot or cold water at the beginning.

#### COMPOSITION OF MEATS COOKED BY ROASTING, BROILING, SAUTÉING, AND FRYING.

The final results of the studies of the changes in composition of meats cooked by roasting, broiling, sautéing, and frying are given in Tables 103 and 104. It seems best to group the results of the analyses of meats cooked by these different methods, in the first place because only a few tests have as yet been made on each of the methods, and in the second place because the nature of the chemical changes brought about by these methods of applying dry heat are apparently quite similar, if we may judge from the results obtained.

TABLE 103.—*Chemical composition of meats cooked by roasting, broiling, sautéing, and frying (fresh substance).*

Laboratory No.	Raw meat used, No.	Cooking experiment No.	Kind of meat.	Water.	Proteid.			Organic extractives.		
					Insoluble.	Soluble.	Total.	Nitrogenous.	Non-nitrogenous.	Total.
1770	1764	146	Beef, round, pot roast.....	<i>Per ct.</i> 51.95	<i>Per ct.</i> 34.22	<i>Per ct.</i> 0.31	<i>Per ct.</i> 34.53	<i>Per ct.</i> 1.40	<i>Per ct.</i> 1.69	<i>Per ct.</i> 3.09
1781	1775	155	.....do.....	52.96	34.19	.42	34.61	1.11	1.17	2.28
			Average .....	52.46	34.20	.37	34.57	1.26	1.43	2.69
1771	1764	147	Beef, round, roast.....	64.63	20.70	.75	21.45	1.36	1.55	2.91
1782	1775	156	.....do.....	68.58	21.96	1.23	23.19	.94	1.27	2.21
			Average .....	66.61	21.33	.99	22.32	1.15	1.41	2.56



TABLE 103.—*Chemical composition of meats cooked by roasting, broiling, sautéing, and frying (fresh substance)*—Continued.

Laboratory No.	Raw meat used, No.	Cooking experiment No.	Kind of meat.	Water.	Proteid.			Organic extractives.		
					Insoluble.	Soluble.	Total.	Nitrogenous.	Non-nitrogenous.	Total.
				<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1660	1662	120	Veal, leg, roast.....	68.35	23.28	0.41	23.69	1.34	1.89	3.23
			Average Nos. 1660, 1771, and 1782...	67.19	21.98	.80	22.78	1.21	1.57	2.78
1778	1775	152	Beef, round, gas broiled.	66.26	21.95	.83	22.78	1.38	1.62	3.00
1766	1764	142	Beef, round, pan broiled.	65.61	20.94	1.37	22.31	1.46	1.72	3.18
1777	1775	151	.....do.....	65.74	24.16	.58	24.74	1.48	1.72	3.20
			Average Nos. 1766 and 1777.....	65.68	22.55	.98	23.53	1.47	1.72	3.19
1674	1676	124	Beef, rump, pan broiled.	27.46	21.24	.27	21.51	1.07	1.33	2.40
1659	1662	119	Veal, leg, pan broiled...	65.33	26.29	.42	26.71	1.33	1.84	3.17
			Average Nos. 1659, 1674, 1766, and 1777.....	56.04	23.16	.66	23.82	1.34	1.65	2.99
1765	1764	141	Beef, round, sautéed....	64.02	21.48	1.03	22.51	1.38	1.69	3.07
1776	1775	150	.....do.....	66.66	22.04	.73	22.77	1.37	1.61	2.98
			Average.....	65.34	21.76	.88	22.64	1.38	1.65	3.03
1767	1764	143	Beef, round, fried.....	57.78	27.06	.53	27.59	1.62	1.83	3.45
			Average all beef a.	62.42	24.87	.78	25.65	1.36	1.58	2.94
			Average all veal ..	66.84	24.79	.41	25.20	1.34	1.87	3.21
			Average beef a and veal .....	63.16	24.86	.72	25.58	1.36	1.63	2.99
			Average roasts, gas broiled, pan broiled, and sautéed a .....	66.14	22.54	.82	23.36	1.35	1.65	3.00

Laboratory No.	Raw meat used, No.	Cooking experiment No.	Kind of meat.	Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Non-proteid nitrogen.	Ratio of non-proteid to proteid nitrogen.
				<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	
1770	1764	146	Beef, round, pot roast.	9.66	1.21	100.44	5.972	5.524	0.448	1:12.3
1781	1775	155	.....do.....	9.87	1.10	100.82	5.891	5.537	.354	1:15.6
			Average .....	9.77	1.16	100.63	5.932	5.531	.401	1:13.8
1771	1764	147	Beef, round, roast.....	9.50	1.17	99.66	3.870	3.432	.438	1: 7.8
1782	1775	156	.....do.....	5.42	1.16	100.56	4.011	3.711	.300	1:12.4
			Average.....	7.46	1.17	100.11	3.941	3.572	.369	1: 9.7
1660	1662	120	Veal, leg, roast .....	4.65	1.36	101.28	4.220	3.791	.429	1: 8.8
			Average Nos. 1660, 1771, and 1782.....	6.52	1.23	100.50	4.034	3.645	.389	1: 9.4
1778	1775	152	Beef, round, gas broiled.....	7.64	1.22	100.90	4.088	3.645	.443	1: 8.2
1766	1764	142	Beef, round, pan broiled.....	8.18	1.19	100.47	4.037	3.569	.468	1: 7.6
1777	1775	151	.....do.....	5.83	1.24	100.75	4.435	3.959	.476	1: 8.3
			Average Nos. 1766 and 1777..	7.01	1.22	100.61	4.236	3.764	.472	1: 8.0

a Not including No. 1674.

TABLE 103.—*Chemical composition of meats cooked by roasting, broiling, sautéing, and frying (fresh substance)*—Continued.

Laboratory No.	Raw meat used, No.	Cooking experiment No.	Kind of meat.	Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Non-proteid nitrogen.	Ratio of non-proteid to proteid nitrogen.
1674	1676	124	Beef, rump, pan broiled.....	<i>Per ct.</i> 47.39	<i>Per ct.</i> 1.18	<i>Per ct.</i> 99.94	<i>Per ct.</i> 3.786	<i>Per ct.</i> 3.442	<i>Per ct.</i> 0.344	<i>Per ct.</i> 1:10.0
1659	1662	119	Veal, leg, pan broiled.....	5.20	1.44	101.85	4.700	4.274	.426	1:10.0
			Average Nos. 1659, 1674, 1766, and 1777 .....	16.65	1.26	100.75	4.240	3.811	.429	1: 8.9
1765	1764	141	Beef, round, sautéed.....	9.88	1.18	100.66	4.044	3.601	.443	1: 8.1
1776	1775	150	.....do.....	6.34	1.17	99.92	4.083	3.643	.440	1: 8.3
			Average .....	8.11	1.18	100.29	4.064	3.622	.442	1: 8.2
1767	1764	143	Beef, round, fried .....	10.42	1.43	100.67	4.934	4.414	.520	1: 8.5
			Average all beef .....	8.27	1.21	100.49	4.537	4.104	.433	1: 9.5
			Average all veal.....	4.93	1.40	101.67	4.460	4.033	.427	1: 9.4
			Average beef and veal.....	7.72	1.24	100.69	4.524	4.092	.432	1: 9.5
			Average roasts, gas broiled, pan broiled, and sautéed.....	6.96	1.24	100.71	4.166	3.736	.430	1:7.8

a Not including No. 1674.

TABLE 104.—*Chemical composition of meats cooked by roasting, broiling, sautéing, and frying (water-free basis).*

Laboratory No.	Raw meat used, No.	Cooking experiment No.	Kind of meat.	Proteid.			Organic extractives.		
				Insoluble.	Soluble.	Total.	Nitrogenous.	Nonnitrogenous.	Total.
1770	1764	146	Beef, round, pot roast.....	<i>Per ct.</i> 74.01	<i>Per ct.</i> 0.65	<i>Per ct.</i> 74.66	<i>Per ct.</i> 2.58	<i>Per ct.</i> 3.16	<i>Per ct.</i> 5.74
1781	1775	155	.....do.....	72.68	.89	73.57	2.36	2.49	4.85
			Average.....	73.35	.77	74.12	2.47	2.83	5.30
1771	1764	147	Beef, round, roast.....	58.54	2.10	60.64	3.84	4.38	8.22
1782	1775	156	.....do.....	69.90	3.91	73.81	2.99	4.04	7.03
			Average.....	64.22	3.01	67.23	3.42	4.21	7.63
1660	1662	120	Veal, leg, roast .....	73.55	1.30	74.85	4.23	5.97	10.20
			Average Nos. 1660, 1771, and 1782.....	67.33	2.44	69.77	3.69	4.80	8.49
1778	1775	152	Beef, round, gas broiled.....	65.06	2.46	67.52	4.09	4.80	8.89
1766	1764	142	Beef, round, pan broiled.....	60.89	3.98	64.87	4.25	5.00	9.25
1777	1775	151	.....do.....	70.52	1.69	72.21	4.32	5.02	9.34
			Average Nos. 1766 and 1777.....	65.70	2.84	68.54	4.29	5.01	9.30
1674	1676	124	Beef, rump, pan broiled.....	29.28	.37	29.65	1.48	1.83	3.31
1659	1662	119	Veal, leg, pan broiled.....	75.83	1.21	77.04	3.84	5.31	9.15
			Average Nos. 1659, 1674, 1766, and 1777.....	59.13	1.81	60.94	3.47	4.29	7.76
1765	1764	141	Beef, round, sautéed .....	59.69	2.87	62.56	3.84	4.70	8.54
1776	1775	150	.....do.....	66.11	2.19	68.30	4.11	4.83	8.94
			Average.....	62.90	2.53	65.43	3.98	4.77	8.75

TABLE 104.—*Chemical composition of meats cooked by roasting, broiling, sautéing, and frying (water-free basis)*—Continued.

Laboratory No.	Raw meat used, No.	Cooking experiment No.	Kind of meat.	Proteid.			Organic extractives.		
				Insoluble,	Soluble.	Total.	Nitrogenous.	Non-nitrogenous.	Total.
1767	1764	143	Beef, round, fried .....	<i>Per ct.</i> 64.09	<i>Per ct.</i> 1.26	<i>Per ct.</i> 65.35	<i>Per ct.</i> 3.84	<i>Per ct.</i> 4.33	<i>Per ct.</i> 8.17
			Average all beef <sup>a</sup> .....	66.15	2.20	68.35	3.63	4.28	7.91
			Average all veal .....	74.69	1.26	75.95	4.04	5.64	9.68
			Average all beef <sup>a</sup> and veal .....	67.57	2.05	69.62	3.70	4.51	8.21
			Average roasts, gas broiled, pan broiled, and sautéed .....	66.67	2.42	69.09	3.96	4.90	8.86
Laboratory No.	Raw meat used, No.	Cooking experiment No.	Kind of meat.	Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Non-proteid nitrogen.
				<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1770	1764	146	Beef, round, pot roast .....	18.51	2.34	101.25	12.429	11.946	0.483
1781	1775	155	.....do .....	20.98	2.34	101.71	12.523	11.772	.751
			Average .....	19.75	2.34	101.48	12.476	11.859	.617
1771	1764	147	Beef, round, roast .....	26.86	3.31	99.03	10.941	9.702	1.239
1782	1775	156	.....do .....	17.25	3.69	101.78	12.766	11.810	.956
			Average .....	22.06	3.50	100.41	11.854	10.756	1.098
1660	1662	120	Veal, leg, roast .....	14.69	4.30	104.04	13.333	11.976	1.357
			Average Nos. 1660, 1771, and 1782 .....	19.60	3.77	101.62	12.347	11.163	1.184
1778	1775	152	Beef, round, gas broiled .....	22.64	3.62	102.67	12.116	10.803	1.313
1766	1764	142	Beef, round, pan broiled .....	23.79	3.46	101.37	11.739	10.379	1.360
1777	1775	151	.....do .....	17.02	3.62	102.19	12.945	11.554	1.391
			Average Nos. 1766 and 1777 .....	20.41	3.54	101.78	12.342	10.967	1.376
1674	1676	124	Beef, rump, pan broiled .....	65.33	1.63	99.92	5.218	4.744	.474
1659	1662	119	Veal, leg, pan broiled .....	15.00	4.15	105.34	13.556	12.326	1.230
			Average Nos. 1659, 1674, 1766, and 1777 .....	30.29	3.22	102.21	10.865	9.751	1.114
1765	1764	141	Beef, round, sautéed .....	27.46	3.28	101.84	11.240	10.010	1.230
1776	1775	150	.....do .....	19.02	3.51	99.77	12.247	10.928	1.319
			Average .....	23.24	3.40	100.81	11.744	10.469	1.275
1767	1764	143	Beef, round, fried .....	24.68	3.39	101.59	11.687	10.456	1.231
			Average all beef <sup>a</sup> .....	21.82	3.26	101.32	12.064	10.936	1.128
			Average all veal .....	14.85	4.23	104.69	13.445	12.151	1.294
			Average all beef <sup>a</sup> and veal .....	20.66	3.42	101.88	12.294	11.139	1.155
			Average roasts, gas broiled, pan broiled, and sautéed .....	20.42	3.66	102.00	12.321	11.055	1.266

<sup>a</sup>Not including No. 1674.

Upon examining Table 103 it will be readily noted that the amount of water contained in meats cooked by roasting, gas broiling, pan broiling, and sautéing is decidedly greater than it is in meats cooked by boiling or in meats cooked by pot roasting and frying, the average water content in 9 samples of roast, gas broiled, pan broiled, and sautéed meat being 66.13 per cent as compared with 57.50, the average percentage of water in 31 samples of meat cooked in hot water. Two samples of pot roasted meat showed an average of 52.46 per cent of water, while one sample of fried meat contained 57.78 per cent of water. It will be remembered that the average content of the 13 samples of uncooked meats was 70.08. Since meats cooked by roasting, gas broiling, pan broiling, and sautéing contain a considerably higher percentage of water than do meats cooked by boiling, it follows that if the losses resulting from the cooking are the same the former will be poorer in insoluble proteid, total proteid, fat, and other constituents.

As will be seen (Table 103), the percentages of insoluble and total proteid are much smaller in the roast, gas broiled, pan broiled, and sautéed than in the boiled meats. The average total proteid in the former case is 23.36 per cent and in the latter 31.95 per cent. With regard to the fat it is difficult to draw definite conclusions, since in the first place this constituent is subject to such wide variations in the uncooked meat, and in the second place the proportion of fat removed by boiling is much greater than it is in the other methods of cooking.

When we compare the soluble constituents, i. e., soluble proteids, nitrogenous and nonnitrogenous extractives, and ash of the meats cooked by roasting, gas broiling, pan broiling, pot roasting, frying, and sautéing, with those of meat cooked in hot water, striking differences are noted, all of the soluble constituents occurring in meats being found in much smaller proportion in the latter than in the others. As shown by the average of the analyses of 12 samples, pot roasted, gas broiled, pan broiled, fried, and sautéed meat contained the following: Soluble proteid 0.72 per cent, nitrogenous extractives 1.36 per cent, nonnitrogenous extractives 1.65 per cent, total organic extractives 2.99 per cent, and ash 1.24 per cent. Referring to Table 102, page 110, it will be seen that the average of 31 analyses of boiled meats gave the following: Soluble proteid 0.38 per cent, nitrogenous extractives 0.60 per cent, nonnitrogenous extractives 0.75 per cent, total extractives 1.35 per cent, and ash 0.66 per cent. It is thus evident that there is a marked difference in the chemical composition of meats cooked by methods which do not necessitate contact with water and those cooked by immersion in hot water. Meats cooked without immersion in water contain, as a rule, more than twice as much of the soluble organic and inorganic substances which have so much to do with the production of flavor as those cooked in hot water.

Another marked difference between meats cooked by the different methods is apparent in the ratio of the nonproteid to the proteid nitrogen. In the case of meats cooked by other methods than immersion in hot water, the ratio on an average was 1:9.5, as compared with 1:26.8 in the case of meats cooked in hot water. It is evident that there is a fundamental difference in the nature of the chemical changes and the losses which result when meats are cooked in hot water and when they are cooked by other methods. Such marked differences in chemical composition must undoubtedly be accompanied by differences in nutritive value, and therefore in economic value. Exactly what these differences are must be determined mainly by further investigation.

Finally, attention should be called to the fact that the available data indicate clearly that the meats cooked by methods other than immersion in hot water resemble uncooked meats in chemical composition much more than do meats cooked by boiling. This is evident in the amount of water which they contain. The average amount of water found in the analysis of 13 samples of uncooked meats was 70.08 per cent. The analysis of 12 samples of roasted, broiled, sautéed, and fried meats was 63.16 per cent, and 31 samples of boiled meats was 57.50. This closer resemblance of meats cooked by dry heat to uncooked meats is also shown by the amounts of nitrogenous and nonnitrogenous organic extractives and ash which they contain. Twelve samples of beef and veal (see pages 114 and 117), cooked by one or another of the dry methods, contained on an average 1.36 per cent nitrogenous extractives, 1.63 per cent of nonnitrogenous extractives, 2.99 per cent total organic extractives, and 1.24 per cent ash. Thirteen samples of uncooked meats gave the following average figures: 1.09 per cent nitrogenous extractives, 1.63 per cent nonnitrogenous extractives, 2.72 per cent total organic extractives, and 1.04 per cent ash. In the case of the 31 samples of boiled meats the average values were 0.60 per cent nitrogenous extractives, 0.75 per cent nonnitrogenous extractives, 1.35 per cent total organic extractives, and 0.66 per cent ash.

Meats cooked by dry heat also resemble raw meats in the ratio of nonproteid to proteid nitrogen, the value being 1:9.5 and 1:8.2, respectively, and for boiled meats 1:26.8.

These comparisons are also brought out in Tables 105 and 106.



TABLE 105.—*Chemical composition of cooked and uncooked meats (fresh substance).*

Kind of meat and method of cooking.	No. in average.	Water.	Proteid.			Organic extractives.		
			Insoluble.	Soluble.	Total.	Nitrogenous.	Non-nitrogenous.	Total.
Beef, raw .....	11	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
Beef, raw .....	2	69.13	15.52	2.29	17.81	1.08	1.62	2.70
Beef, boiled three hours .....	14	75.75	16.23	2.37	18.60	1.17	1.66	2.83
Beef, boiled five hours .....	17	57.07	34.35	.26	34.61	.75	.88	1.63
Beef, boiled three and five hours .....	31	57.86	29.41	.47	29.88	.47	.65	1.12
Beef, pot roast .....	2	57.50	31.57	.38	31.95	.60	.75	1.35
Beef, roast .....	2	52.46	34.20	.37	34.57	1.26	1.43	2.69
Beef, gas broiled .....	1	66.61	21.33	.99	22.32	1.15	1.41	2.56
Beef, pan broiled .....	3	68.35	23.28	.41	23.69	1.34	1.89	3.23
Beef, sautéed .....	2	66.26	21.95	.83	22.78	1.38	1.62	3.00
Beef, fried .....	1	52.94	22.11	.74	22.85	1.34	1.59	2.93
Beef, gas broiled .....	1	65.33	26.29	.42	26.71	1.33	1.84	3.17
Beef, pan broiled .....	1	65.33	26.29	.42	26.71	1.33	1.84	3.17
Beef, sautéed .....	2	65.34	21.76	.88	22.64	1.38	1.65	3.03
Beef, fried .....	1	57.78	27.06	.53	27.59	1.62	1.83	3.45

Kind of meat and method of cooking	Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Non-proteid nitrogen.	Ratio of non-proteid to proteid nitrogen.
	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	
Beef, raw .....	<i>a</i> 10.95	1.03	<i>a</i> 100.65	3.195	2.849	0.346	1: 8.3
Beef, raw .....	2.48	1.13	100.77	3.350	2.975	.375	1: 7.9
Beef, boiled three hours .....	6.49	.73	100.53	5.778	5.537	.241	1: 23.0
Beef, boiled five hours .....	<i>b</i> 11.84	.60	<i>b</i> 100.87	4.932	4.782	.150	1: 31.9
Beef, boiled three and five hours .....	<i>c</i> 9.34	.96	<i>c</i> 100.71	5.314	5.123	.191	1: 26.8
Beef, pot roast .....	9.77	1.16	100.63	5.932	5.531	.401	1: 13.8
Beef, roast .....	7.46	1.17	100.11	3.941	3.572	.369	1: 9.7
Beef, gas broiled .....	4.65	1.36	101.28	4.220	3.791	.429	1: 8.8
Beef, pan broiled .....	7.64	1.22	100.90	4.088	3.645	.443	1: 8.2
Beef, sautéed .....	20.47	1.20	100.39	4.086	3.657	.429	1: 8.5
Beef, fried .....	5.20	1.44	101.85	4.700	4.274	.426	1: 10.0
Beef, gas broiled .....	8.11	1.18	100.29	4.064	3.622	.442	1: 8.2
Beef, pan broiled .....	10.42	1.43	100.67	4.934	4.414	.520	1: 8.5

*a* Average of 10.*b* Average of 16.*c* Average of 30.TABLE 106.—*Chemical composition of cooked and uncooked meats (water-free basis).*

Kind of meat and method of cooking.	No. in average.	Proteid.			Organic extractives.		
		Insoluble.	Soluble.	Total.	Nitrogenous.	Non-nitrogenous.	Total.
Beef, raw .....	11	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
Beef, raw .....	2	54.45	8.14	62.59	3.83	5.78	9.61
Beef, boiled three hours .....	14	66.94	9.77	76.71	4.83	6.84	11.67
Beef, boiled five hours .....	17	80.06	.61	80.67	1.74	2.05	3.79
Beef, boiled three and five hours .....	31	72.95	1.16	74.11	1.18	1.66	2.84
Beef, pot roast .....	2	79.16	.91	77.07	1.43	1.84	3.27
Beef, roast .....	2	73.35	.77	74.12	2.47	2.83	5.30
Beef, gas broiled .....	1	64.22	3.01	67.23	3.42	4.21	7.63
Beef, pan broiled .....	1	73.55	1.30	74.85	4.23	5.97	10.20
Beef, sautéed .....	1	65.06	2.46	67.52	4.09	4.80	8.89
Beef, fried .....	3	53.56	2.02	55.58	3.35	3.95	7.30
Beef, gas broiled .....	1	75.83	1.21	77.04	3.84	5.31	9.15
Beef, pan broiled .....	2	62.90	2.53	65.43	3.98	4.77	8.75
Beef, sautéed .....	1	64.09	1.26	65.35	3.84	4.33	8.17



TABLE 106.—*Chemical composition of cooked and uncooked meats (water-free basis)—Continued.*

Kind of meat and method of cooking.	Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Nonproteid nitrogen.
	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
Beef, raw .....	<i>a</i> 30.54	3.59	<i>a</i> 102.27	11.244	10.014	1.230
Veal, raw .....	10.15	4.65	103.16	13.820	12.273	1.547
Beef, boiled three hours .....	15.08	1.69	101.22	13.466	12.906	.560
Beef, boiled five hours .....	<i>b</i> 24.63	1.52	<i>b</i> 102.30	12.234	11.857	.377
Beef, boiled three and five hours .....	<i>c</i> 20.17	1.60	<i>c</i> 101.80	12.790	12.331	.459
Beef, pot roast .....	19.75	2.34	101.48	12.476	11.634	.842
Beef, roast .....	22.06	3.50	100.41	11.854	10.756	1.098
Veal, roast .....	14.69	4.30	104.04	13.333	11.976	1.357
Beef, gas broiled .....	22.64	3.62	102.67	12.116	10.803	1.313
Beef, pan broiled .....	35.38	2.90	101.16	9.967	8.893	1.075
Veal, pan broiled .....	15.00	4.15	105.34	13.556	12.326	1.230
Beef, sautéed .....	23.24	3.40	100.81	11.744	10.469	1.275
Beef, fried .....	24.68	3.39	100.59	11.687	10.456	1.231

*a* Average of 10.*b* Average of 16.*c* Average of 30.

### SOLUBILITY OF UNCOOKED AND COOKED MEATS IN COLD WATER.

Previous investigations have shown that a study of the solubility in cold water of meats before and after cooking is of value in determining the nature of the chemical changes which meats undergo during the processes of cooking. Furthermore, it seems more than probable, especially in the light of Armsby's recent experiments on the expenditure of energy in digestion and assimilation,<sup>a</sup> that a study of the solubility of meats in cold water would throw some light upon their real nutritive value and upon the ease and rapidity of their digestion and assimilation, since experimental data indicate clearly that, other conditions being the same, the easily soluble nutrients of foods are masticated, digested, and assimilated by the animal body with the expenditure of less energy than are the less soluble or the insoluble nutrients. Again, though the amount of fat present has a decided effect, the flavor of meats and of other foods also is undoubtedly due chiefly to the soluble constituents present; that is to say, the substances which give flavor to meats will be found in the cold-water extracts.

The statements are in accord with Rubner's<sup>b</sup> conclusions. He says in effect that the tenderer the meat the more easily are the flesh bases extracted by the saliva, and, other things being equal, the more pronounced is the pleasant flavor. He further maintains that the quality of meat also depends upon the kind and amount of the flesh bases. The character of the feed the animals have received has an effect upon flavor and quality, as do also age and sex.

In discussing the results of the study of the hemoglobin content of

<sup>a</sup> Armsby, *Principles of Animal Nutrition*, 1904, p. 372.

<sup>b</sup> E. von Leyden. *Handbuch der Ernährungstherapie*. Leipsic, 1903. 2. ed., p. 86.

muscular tissue Lehmann and associates<sup>a</sup> point out that generally, though not always, other soluble constituents are present in abundance when the hemoglobin content is high. In other words, the red meats usually contain the largest amount of extractives and hence have the most pronounced flavor (exclusive of that due to fat). Although other factors undoubtedly exert more or less influence upon it, the hemoglobin content is very largely determined by exercise. In birds the much used muscles contain about three times as much as do those which are little used. In game the hemoglobin content is very high. The flesh of young animals contains less hemoglobin than that of old animals owing to the fact that the muscles have been little used. Since the amount of other extractives is usually directly proportional to the hemoglobin content, it is obvious that exercise and other factors which influence the amount of blood present in the muscular tissue may affect the flavor of meat very materially.

Flavor—that is, the kind and amount of soluble bodies present in meat—is known to be influenced by hanging and storing. If putrefactive changes are not prevented amin bodies and later other compounds of very pronounced odor and flavor are produced, as was pointed out by C. Mai<sup>b</sup> in a study of meat putrefaction. Cold storage checks the action of putrefactive bacteria, but not that of the enzymes normally present in meat. The decided changes in flavor and texture which are noted when meat ripens in cold storage and which are entirely different from putrefactive changes are attributed to the continued action of these unorganized ferments. Meat which has hung for a time is generally considered of better flavor than that which is freshly killed. According to M. Müller,<sup>c</sup> who has studied the changes brought about by enzymes, meat held in cold storage is especially satisfactory for roasting or broiling, but from the standpoint of flavor of both meat and broth is not as good as freshly slaughtered meat for boiling.

In view of these considerations it is evident that more information regarding the quantities and the nature and character of the materials extracted from uncooked and cooked meats is highly desirable.

#### COMPOSITION OF THE COLD-WATER EXTRACTS OF UNCOOKED MEATS.

The quantity and the nature of the substances extracted from meats by either cold or hot water has apparently been studied but little. As far back as 1847 Justus Liebig,<sup>d</sup> in his classical research on the nature of the constituents of meat juice, determined in one or two instances

<sup>a</sup> *Ztschr. Biol.*, 45 (1903), p. 324.

<sup>b</sup> *Ztschr. Untersuch. Nahr. u. Genussmtl.*, 4 (1901), p. 18.

<sup>c</sup> *Arch. Hyg.*, 47 (1903), p. 127.

<sup>d</sup> Liebig's *Ann. Chem.*, 62 (1847), p. 257.

the total quantity of beef and chicken flesh which was soluble in cold and in hot water. With beef flesh he obtained the following results: Material soluble in cold water, 6 per cent; material other than fat, insoluble in cold water, 17 per cent; fat, 2 per cent, and water, 75 per cent. Of the 6 per cent of material soluble in water, 2.95 per cent was coagulated by heat, the balance, 3.05 per cent, remaining in solution in hot water. Of the 17 per cent of insoluble material other than fat, 0.6 per cent was gelatinoids, since it was made soluble by boiling with water. In the case of chicken flesh, 8 per cent of material soluble in cold water was found, of which 4.70 per cent was coagulated by heat and 3.30 per cent remained dissolved in the hot water.

Other investigators, about the time of Liebig or soon after, made cold-water extracts of different kinds of flesh mainly with a view to securing material for detailed analysis by the ordinary method; but, while the results of their complete analyses are on record,<sup>a</sup> we have not as yet found a description of the methods which they employed, nor have we found the results of their direct analyses of the water extracts. In view of these facts, it does not seem necessary to consider their work further in this connection.

There have been in later years, however, a number of investigations which should be referred to, namely, those of Almen,<sup>b</sup> Atwater and associates,<sup>c</sup> Henneberg and associates,<sup>d</sup> Wiley and associates,<sup>e</sup> and Gautier,<sup>f</sup> which are also mentioned on page 96 in connection with the discussion of the results of the chemical composition of uncooked and cooked meats.

In his study of fish, Almen prepared a cold-water extract of the flesh, and determined the albumin by coagulation by heat in the presence of a few drops of acetic acid, and the extractives by evaporating the water extract to dryness and weighing after removing the coagulated proteid. This residue was then ignited in order to determine the amount of soluble ash, which was subtracted from the total weight of the residue, the remainder being designated "extractives." Referring to the data on pages 98 and 99, it will be seen that the extractives as obtained by Almen's method correspond to the sum of the nitrogenous and nonnitrogenous extractives and the albumoses as obtained by the method used in the present investigations. Almen also determined the gelatinoids in the flesh of fish by treating the residue insoluble in cold water with boiling water for twelve hours. The resulting solution was evaporated to constant weight and calculated

<sup>a</sup> Fremy, *Encyclopedie Chimique*, vol. 9, p. 467.

<sup>b</sup> *Analyse der Fleisches einiger Fische*. Upsala, 1877.

<sup>c</sup> U. S. Fish Commission Rpt. 1880, p. 231.

<sup>d</sup> *Jour. Landw.* (1878), p. 549.

<sup>e</sup> U. S. Dept. Agr., Bureau of Chemistry Bul. 53.

<sup>f</sup> *Rev. Hyg. et Pol. Sanit.*, 19 (1897), p. 394.

as gelatinoids. After deducting the fat and insoluble ash, the residue left after treatment with hot water was designated "insoluble proteid" (Fleischfaser).

Atwater and his associates, in their study of the chemical composition of fish flesh, determined the ingredients soluble in cold and in hot water in a number of samples. They prepared the extract by digesting 33.33 grams of the freshly chopped flesh eighteen to twenty-four hours in 500 cubic centimeters of cold water and then filtered it. The soluble albumin was determined by heating the cold-water extract to coagulation, filtering, washing with water and ether, drying, and weighing. The total amount of matter other than coagulable proteid dissolved by the cold water was determined by evaporating to dryness measured quantities of the filtrate from the coagulable proteid and weighing. One sample of the dry residue was used for the determination of the ash, and another finely ground was used for the estimation of fat. The total quantity of ash and fat thus obtained was subtracted from the crude extract in order to get the true extract, which was designated "extractive matters." The same investigators also determined the gelatinoids in fish flesh by treating the residue, insoluble in cold water, with boiling water for about twenty hours. The resulting solution was then filtered, the filtrate evaporated to dryness, and weighed as crude gelatin. In this fat and ash were determined and the pure gelatin was estimated by deducting the quantities of ash and fat from the crude residue left upon evaporation. The methods used by Atwater and coworkers are quite similar to those used by Almen, but it is apparent from the records available that in the American work greater precautions were taken with certain determinations to get concordant and accurate results.

Henneberg, Kern, and Wattenberg, in their investigation of the chemical composition of mutton, determined the extractives by the following method: Fifty grams of the fresh flesh were repeatedly treated with small quantities of cold water until the volume of the resulting filtrates measured 1,000 cubic centimeters. Portions of this filtrate were used for the estimation of ash, total dissolved matter, total nitrogen, and nitrogen in the solution after removing the coagulated albumin. The proteid nitrogen—i. e., that coagulated by heat—was also determined by difference. For purposes of comparison or as a test of the accuracy of the work, the proteid coagulated by heat was also removed, dried, and weighed. The figures for nonproteid nitrogen were multiplied by the factor 6.25 in order to get the amount of the so-called nonproteid extractives. The results obtained by Henneberg and associates with mutton flesh are comparable with those of Atwater and Almen with fish flesh.

Stated briefly, the methods used by Wiley and associates were as

follows: The fresh meat was air-dried at a temperature of 100° C. or slightly higher, until the fat had very largely separated. The fat was poured off and the drying continued until the weight became approximately constant, when the residues thus obtained were extracted with ether to remove any remaining fat. The extracted flesh was dried to approximately constant weight and then left exposed to the air for at least twenty-four hours and again weighed. One-gram portions of the air-dried sample thus prepared were washed with ether, and after the ether had been allowed to evaporate were treated repeatedly with small quantities of water until 300 to 400 cubic centimeters had been used. The nitrogen in the insoluble residues was determined by the Kjeldahl method. The filtrates from the insoluble portions of the meat were placed in Kjeldahl flasks and used for the determination of the material precipitated by bromin (gelatinoids). The nitrogen in the bromin precipitates was determined by the Kjeldahl method. The percentage of nitrogen in the form of nitrogenous extractives (flesh bases) was found by subtracting the sum of the figures representing insoluble nitrogen and nitrogen precipitated by bromin, from the figures for total nitrogen. In calculating the percentage of flesh bases, the factor 3.12 was used, and for the other forms of nitrogen, the factor 6.25. It is evident from this outline that the results obtained are not directly comparable with those of the other investigations here mentioned, since air-dried samples of flesh were used, and there is much evidence to show that in the preparation of such samples, fresh meats undoubtedly undergo various fundamental chemical changes.

Notwithstanding the fact that so far we have not been able to learn the methods used by Gautier in his investigations with meats, his results are of decided interest, and the values which he reports for the composition of meat are summarized, with the data of the other investigators referred to, in the following table:

TABLE 107.—*Summary of analyses of cold-water extracts of meats.*

Kind of meat.	No. of analyses.	Organic extractives.				Fat.	Ash.	Total solid matter.	Nitrogen.			Ratio of nonprotein to proteid nitrogen.
		Proteid.	Nitrogenous.	Nonnitrogenous.	Total.				Total.	Proteid.	Nonproteid.	
Fish (fresh), Almen .....	8	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	
Fish (salt), Almen .....	5	2.49	.....	.....	1.93	.....	.....	.....	.....	.....	.....	.....
Fish (fresh), Atwater .....	24	1.46	.....	.....	3.56	.....	.....	.....	.....	.....	.....	.....
Fish (cured), Atwater .....	7	1.55	.....	.....	1.95	.....	.....	.....	.....	.....	.....	.....
Mutton (fresh) <sup>a</sup> , Henneberg ..	14	.61	.....	.....	3.66	.....	.....	.....	.....	.....	.....	.....
Pork (air-dried) <sup>b</sup> , Wiley .....	88	1.61	.....	.....	2.18	.....	1.21	5.00	0.589	0.258	0.331	1: 0.78
Beef (fresh), Gautier .....	1	.....	1.14	.....	.....	.....	.....	.....	.541	.176	.365	1: .48
Mutton (fresh), Gautier ....	1	3.06	2.24	0.97	3.21	0	.65	6.92	.....	.....	.....	.....
	1	3.32	1.33	.59	1.92	0	.60	5.84	.....	.....	.....	.....

<sup>a</sup> Results calculated to fat-free substance.

<sup>b</sup> The samples were air-dried before analysis, but the results have been calculated to fresh substance.



From the above summary it is apparent that the present knowledge of the cold-water extracts of various kinds of meats is very incomplete. The results of Gautier are the most detailed of those which have been found on record, although even here it is impossible to calculate the proteid and nonproteid nitrogen from his published results. Further, the values for the nonnitrogenous organic extractives as presented in the above table are not altogether satisfactory, since it was necessary for the authors of this bulletin to recalculate and readjust Gautier's published results in order to include them in the tabular comparison. This could not be done with assured accuracy without a knowledge of the analytical methods which he employed.

A number of investigators have reported studies of special groups of meat extractives, such as xanthin and other purin bodies, which should be referred to in this connection. I. W. Hall<sup>a</sup> has summarized the work of earlier investigators on purin bodies and reported the results of a number of original investigations. His recently published volume includes an extended bibliography.

The numerous investigations which have been made of the composition of commercial meat extract have a direct bearing on the question of soluble constituents of meat, but it does not necessarily follow that all constituents found in the extract existed in the muscular tissue, since some may be cleavage products formed when the meat juice was evaporated.

In a recently published study of meat extract, F. Kutscher<sup>b</sup> reports methylguanidin and a number of hitherto unknown nitrogenous bodies. It is undoubtedly true that such bodies, if they exist in the muscular tissue, are present in very small amounts; however, the results of this and other recently published works of a similar nature should be taken into account in future investigations.

In this summary no reference has been made to the numerous investigations which have been reported on the amount and proportion of glycogen and other carbohydrate constituents of flesh, as attention was directed especially to the nitrogenous bodies which exist in meat.

In the present investigation, detailed studies were made of the cold-water extracts of meat, and the data obtained are summarized in the following pages. Tables Nos. 108-113 show the total amount of soluble material in the raw and cooked meats, as well as the kind and cut of meat, the method of cooking, and the chemical nature of the material dissolved by cold water.

In Tables 108 and 109 data are summarized regarding the composition of the cold-water extracts of different kinds and cuts of raw meat.

<sup>a</sup> The Purin Bodies of Food Stuffs. Philadelphia, 1904, 2. ed.

<sup>b</sup> Ztschr. Untersuch. Nahr. u. Genussmtl., 10 (1905), p. 528.

TABLE 108.—*Chemical composition of the cold-water extracts of raw meats, expressed in terms of the total weight of meat taken.*

Cooking experiment No.	Laboratory No.	Kind of meat.	Organic extractives.				Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Non-proteid nitrogen.	Ratio of non-proteid to proteid nitrogen.
			Proteid.	Nitrogenous.	Non-nitrogenous.	Total.							
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	
122	1672	Beef, flank, raw ....	1.21	0.77	0.96	1.73	0	0.55	3.49	0.440	0.194	0.246	1:0.79
121	1668	Beef, neck, raw ....	2.30	.81	1.63	2.44	0	.77	5.51	.627	.368	.259	1:1.42
107	1637	Beef, round, raw ....	2.76	1.08	2.22	3.30	0	.98	7.04	.790	.442	.348	1:1.27
108-109	1640	.....do.....	2.77	1.37	1.72	3.09	0	.98	6.84	.883	.443	.440	1:1.01
110-113	1647	.....do.....	1.82	1.41	1.95	3.36	0	.94	6.12	.744	.292	.452	1: .65
131-132	1722	.....do.....	2.70	1.12	1.99	3.11	0	.89	6.70	.791	.432	.359	1:1.21
133-136	1741	.....do.....	2.80	1.24	1.78	3.02	0	.89	6.71	.846	.448	.398	1:1.13
137-140	1753	.....do.....	2.39	1.11	1.52	2.63	0	.92	5.94	.739	.383	.356	1:1.08
141-147	1764	.....do.....	2.70	1.18	1.73	2.91	0	.73	6.34	.811	.433	.378	1:1.15
150-156	1775	.....do.....	2.20	1.13	1.40	2.53	0	.87	5.60	.714	.352	.362	1: .97
		Average Nos.1637, 1640, 1647, 1722, 1741, 1753, 1764, and 1775 .....	2.52	1.21	1.79	3.00	0	.90	6.42	.790	.403	.387	1:1.04
123-124	1676	Beef, rump, raw ....	1.54	.66	.88	1.54	0	.61	3.69	.456	.246	.210	1:1.17
		Average of all beef samples .....	2.29	1.08	1.62	2.70	0	.83	5.82	.713	.367	.346	1:1.06
114-116	1656	Veal, leg, raw .....	2.83	1.26	1.94	3.20	0	1.00	7.03	.855	.452	.403	1:1.12
117-120	1662	.....do.....	1.90	1.08	1.37	2.45	0	.91	5.26	.650	.303	.347	1: .87
		Average .....	2.37	1.17	1.66	2.83	0	.95	6.15	.753	.378	.375	1:1.01
		Average of all beef and veal samples .....	2.30	1.09	1.63	2.72	0	.85	5.87	.719	.369	.350	1:1.05

TABLE 109.—*Chemical composition of cold-water extracts of meats (water-free basis).*

Cooking experiment No.	Laboratory No.	Kind of meat.	Organic extractives.				Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Non-proteid nitrogen.
			Proteid.	Nitrogenous.	Non-nitrogenous.	Total.						
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
122	1672	Beef, flank, raw ....	2.99	1.89	2.35	4.24	0	1.35	8.58	1.078	0.478	0.600
121	1668	Beef, neck, raw ....	8.02	2.82	5.68	8.50	0	2.68	19.20	2.183	1.283	.900
107	1637	Beef, round, raw ....	11.27	4.41	9.07	13.48	0	4.00	28.75	3.229	1.803	1.426
108-109	1640	.....do.....	10.68	5.28	6.62	11.90	0	3.77	26.35	3.401	1.709	1.692
110-113	1647	.....do.....	7.05	5.46	7.55	13.01	0	3.64	23.70	2.881	1.128	1.753
131-132	1722	.....do.....	9.86	4.08	7.25	11.33	0	3.25	24.44	2.885	1.578	1.307
133-136	1741	.....do.....	10.15	4.50	6.46	10.96	0	3.23	24.34	3.071	1.624	1.447
137-140	1753	.....do.....	9.09	4.21	5.77	9.98	0	3.47	22.54	2.805	1.454	1.351
141-147	1764	.....do.....	9.00	3.92	5.75	9.67	0	2.44	21.11	2.695	1.440	1.265
150-156	1775	.....do.....	8.23	4.23	5.24	9.47	0	3.26	20.96	2.673	1.317	1.356
		Average Nos.1637, 1640, 1647, 1722, 1741, 1753, 1764, and 1765 .....	9.42	4.51	6.71	11.22	0	3.38	24.02	2.955	1.507	1.448
123-124	1676	Beef, rump, raw ....	3.23	1.38	1.84	3.22	0	1.28	7.73	.955	.517	.438
		Average of all beef samples .....	8.14	3.83	5.78	9.61	0	2.94	20.69	2.532	1.303	1.229
114-116	1656	Veal, leg, raw .....	11.78	5.24	8.07	13.31	0	4.16	29.25	3.558	1.885	1.673
117-120	1662	.....do.....	7.76	4.41	5.60	10.01	0	3.72	21.49	2.658	1.242	1.416
		Average .....	9.77	4.83	6.84	11.67	0	3.94	25.38	3.108	1.564	1.544
		Average of all beef and veal samples .....	8.39	3.98	5.94	9.92	0	3.09	21.41	2.621	1.343	1.278

The data presented show that a considerable proportion of raw flesh is soluble in cold water. In the case of 11 samples of beef flesh, the extracted material contained on an average 2.29 per cent proteid, 1.08 per cent flesh bases (nitrogenous organic extractives), 1.62 per cent nonnitrogenous organic extractives, 2.70 per cent total organic extractives, and 0.83 per cent ash, making a total of 5.82 per cent soluble matter. The total nitrogen dissolved by cold water averaged 0.713 per cent, and of this total nitrogen 0.367 per cent existed in the form of proteid and 0.346 per cent as nonproteid nitrogen. The ratio of nonproteid nitrogen to proteid nitrogen was 1:1.06.

In the case of two samples of veal the cold-water extract contained on an average 2.37 per cent proteid, 1.17 per cent flesh bases, 1.66 per cent nonnitrogenous organic extractives, 2.83 per cent total organic extractives, and 0.95 per cent ash, giving a total of 6.15 per cent soluble material. The total nitrogen dissolved by cold water averaged 0.753 per cent, of which 0.378 per cent existed as proteid and 0.375 per cent as nonproteid nitrogen. The ratio of the nonproteid to the proteid nitrogen was 1:1.01.

By comparing the data here presented regarding each individual nutrient with the results of the complete analysis of the meat as given in Tables 98 and 99 (pp. 99, 100), it will be observed that 8.67 to 15.03 per cent of the total proteid in the beef was soluble in water, the average for the 11 samples of raw beef being 12.86 per cent and for the 2 samples of veal a somewhat greater proportion. All of the nitrogenous and nonnitrogenous extractives were found to be soluble, while none of the fat of the flesh went into solution in cold water. The greater part of the ash was extracted, the average in the case of beef being 80.58 per cent, and in the case of veal 84.96 per cent.

The total nutrients soluble in cold water, expressed as per cent of the total nutrients in the original meat (see p. 99), varies from 7.63 in beef rump (sample No. 1676) to 28.71 per cent in veal leg (sample No. 1656), the average for beef being 18.46 and for veal 24.54 per cent. In other words, these experiments indicate that from one-fifth to one-fourth of the total nutrients of raw beef and veal are soluble in cold water.

The average results of the experiments here reported also show that the solid matter obtained by treating beef flesh with cold water contains 12.25 per cent nitrogen, 39.34 per cent proteid, 18.56 per cent nitrogenous organic extractives, 27.84 per cent nonnitrogenous organic extractives, and 14.26 per cent ash, but no fat. Judging from the data obtained with two samples, the cold-water extract of veal contains 12.27 per cent nitrogen, 38.60 per cent proteid, 20.36 per cent nitrogenous organic extractives, 25.73 per cent nonnitrogenous organic extractives, and 15.63 per cent ash.

It is evident that the nitrogen existing in the cold-water extracts of raw meats is quite equally divided between proteid and nonproteid substances, the average ratio for 13 samples of beef and veal being 1:1.05.

# COMPOSITION OF THE COLD-WATER EXTRACTS OF MEATS COOKED BY BOILING.

The tables which follow summarize data regarding the composition of cold-water extracts of boiled meat.

TABLE 110.—*Chemical composition of cold-water extracts of meats cooked by boiling (fresh substance).*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Proteid.	Organic extractives.		
				At beginning.	During cooking.			Nitrogenous.	Non-nitrogenous.	Total.
				°C.	°C.	Hours.	Per ct.	Per ct.	Per ct.	Per ct.
1642	1640	109	Beef, round.....	Cold.	85	3	0.13	0.43	0.56	0.99
1754	1753	137	.....do .....	Cold.	85	3	.20	.78	.82	1.60
			Average .....	Cold.	85	3	.17	.61	.69	1.30
1756	1753	139	Beef, round (browned) .	Cold.	85	3	.17	.75	.75	1.50
			Average Nos. 1642, 1754, and 1756 ...	Cold.	85	3	.17	.65	.71	1.36
1746	1741	136	Beef, round (browned) .	85	85	3	.15	.73	.91	1.64
1769	1764	145	Beef, round.....	85	85	3	.21	.95	.88	1.83
1780	1775	154	.....do .....	85	85	3	.13	.80	.92	1.72
			Average Nos. 1769 and 1780 .....	85	85	3	.17	.88	.90	1.78
			Average Nos. 1746, 1769, and 1780 ...	85	85	3	.16	.83	.90	1.73
1641	1640	108	Beef, round.....	100	85	3	.38	.33	.45	.78
1744	1741	134	.....do .....	100	85	3	.33	.79	1.08	1.87
1768	1764	144	.....do .....	100	85	3	.21	.99	1.28	2.27
1779	1775	153	.....do .....	100	85	3	.20	.94	1.04	1.98
			Average .....	100	85	3	.28	.76	.96	1.72
1755	1753	138	Beef, round.....	Cold.	100	3	.44	.74	.90	1.64
1757	1753	140	Beef, round (browned) .	Cold.	100	3	.49	.79	.91	1.70
			Average .....	Cold.	100	3	.47	.77	.90	1.67
1743	1741	133	Beef, round.....	100	100	3	.33	.77	1.04	1.81
1745	1741	135	Beef, round (browned) .	100	100	3	.24	.72	.79	1.51
			Average .....	100	100	3	.29	.75	.91	1.66
			Average of all cooked 3 hours..			3	.26	.75	.88	1.63
1646	1647	113	Beef, round.....	Cold.	65	5	.27	.29	.38	.67
1645	1647	112	.....do .....	Cold.	85	5	.36	.32	.43	.75
1654	1656	116	Veal, leg.....	Cold.	85	5	.60	.29	.96	1.25
1658	1662	118	.....do .....	Cold.	85	5	.31	.44	.55	.99
			Average Nos. 1654 and 1658.....	Cold.	85	5	.46	.37	.75	1.12
			Average Nos. 1645, 1654, and 1658 ...	Cold.	85	5	.42	.35	.65	1.00

TABLE 110.—*Chemical composition of cold-water extracts of meats cooked by boiling (fresh substance)*—Continued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Proteid.	Organic extractives.		
				At beginning.	During cooking.			Nitrogenous.	Non-nitrogenous.	Total.
				°C.	°C.	Hours.	Per ct.	Per ct.	Per ct.	Per ct.
1644	1647	111	Beef, round.....	100	85	5	0.29	0.40	0.57	0.97
1720	1722	131	.....do.....	100	85	5	.16	.65	.15	.80
			Average .....	100	85	5	.23	.53	.36	.89
1665	1668	121	Beef, neck .....	100	85	5	.19	.32	.55	.87
1673	1676	123	Beef, rump.....	100	85	5	.38	.47	.43	.90
1703	1705	125	.....do.....	100	85	5	.38	.29	.34	.63
			Average Nos. 1673 and 1703.....	100	85	5	.38	.38	.39	.77
1669	1672	122	Beef, flank.....	100	85	5	.39	.04	.17	.21
1653	1656	115	Veal, leg.....	100	85	5	.49	.69	1.00	1.69
1664	1662	117	.....do.....	100	85	5	.32	.55	.77	1.32
			Average Nos. 1653 and 1664.....	100	85	5	.41	.62	.89	1.51
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1706, and 1720.....	100	85	5	.33	.43	.50	.93
1639	1637	107	Beef, round.....	100	100	5	.97	.48	1.19	1.67
1643	1647	110	.....do.....	100	100	5	.92	.44	.57	1.01
1721	1722	132	.....do.....	100	100	5	.56	.65	.50	1.15
			Average .....	100	100	5	.82	.52	.75	1.27
1704	1705	126	Beef, rump.....	100	100	5	.90	.53	.72	1.25
1652	1656	114	Veal, leg.....	100	100	5	.44	1.12	1.67	2.79
			Average Nos. 1639, 1643, 1652, 1704, and 1721.....	100	100	5	.76	.64	.93	1.57
			Average of all cooked 5 hours.....				.47	.47	.65	1.12
			Average of all cooked 3 or 5 hours.....				.38	.60	.75	1.35

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Non-proteid nitrogen.	Ratio of non-proteid to proteid nitrogen.
				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	
1642	1640	109	Beef, round.....	0	0.27	1.39	0.160	0.021	0.139	1:0.15
1754	1753	137	.....do.....	0	.55	2.35	.282	.032	.251	1: .13
			Average .....	0	.41	1.88	.221	.027	.194	1: .14
1756	1753	139	Beef, round (browned) ..	0	.50	2.17	.268	.028	.240	1: .12
			Average Nos. 1642, 1754, and 1756....	0	.44	1.97	.237	.027	.210	1: .13
1746	1741	136	Beef, round (browned) ..	0	.51	2.30	.260	.024	.236	1: .18
1769	1764	145	Beef, round.....	0	.63	2.67	.339	.035	.304	1: .10
1780	1775	154	.....do.....	0	.57	2.42	.276	.021	.255	1: .01
			Average Nos. 1769 and 1780.....	0	.60	2.55	.308	.028	.280	1: .10
			Average Nos. 1746, 1769, and 1780....	0	.57	2.46	.292	.026	.266	1: .10



TABLE 110.--*Chemical composition of cold-water extracts of meats cooked by boiling (fresh substance)*—Continued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Non-proteid nitrogen.	Ratio of non-proteid to proteid nitrogen.
				<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	
1641	1640	108	Beef, round.....	0	0.29	1.45	0.168	0.062	0.106	1:0.58
1744	1741	134	.....do.....	0	.53	2.73	.307	.052	.255	1: .20
1768	1764	144	.....do.....	0	.32	2.80	.352	.034	.318	1: .11
1779	1775	153	.....do.....	0	.60	2.78	.332	.032	.300	1: .11
			Average.....	0	.44	2.44	.290	.045	.245	1: .18
1755	1753	138	Beef, round.....	0	.42	2.50	.309	.070	.239	1: .29
1757	1753	140	Beef, round (browned)...	0	.52	2.71	.332	.078	.254	1: .31
			Average.....	0	.47	2.61	.321	.074	.247	1: .30
1743	1741	133	Beef, round.....	0	.57	2.71	.300	.053	.247	1: .21
1745	1741	135	Beef, round (browned)...	0	.51	2.26	.270	.039	.231	1: .17
			Average.....	0	.54	2.49	.285	.046	.239	1: .19
			Average of all cooked 3 hours...	0	.49	2.38	.283	.042	.241	1: .17
1646	1647	113	Beef, round.....	0	.24	1.18	.138	.044	.094	1: .47
1645	1647	112	.....do.....	0	.34	1.45	.161	.057	.104	1: .55
1654	1656	116	Veal, leg.....	0	.50	2.35	.189	.095	.094	1:1.01
1658	1662	118	.....do.....	0	.40	1.70	.190	.050	.140	1: .36
			Average Nos. 1654 and 1658.....	0	.45	2.03	.190	.073	.117	1: .62
			Average Nos. 1645, 1654, and 1658...	0	.41	1.83	.180	.067	.113	1: .60
1644	1647	111	Beef, round.....	0	.38	1.64	.174	.046	.128	1: .36
1720	1722	131	.....do.....	0	.25	1.21	.234	.026	.208	1: .13
			Average.....	0	.31	1.43	.204	.036	.168	1: .21
1665	1668	121	Beef, neck.....	0	.20	1.26	.132	.030	.102	1: .29
1673	1676	123	Beef, rump.....	0	.25	1.53	.212	.061	.151	1: .40
1703	1705	125	.....do.....	0	.28	1.29	.154	.061	.093	1: .66
			Average Nos. 1673 and 1703.....	0	.26	1.41	.183	.061	.122	1: .50
1669	1672	122	Beef, flank.....	0	.20	.80	.077	.063	.014	1:4.50
1653	1656	115	Veal, leg.....	0	.60	2.78	.301	.079	.222	1: .36
1664	1662	117	.....do.....	0	.53	2.17	.227	.052	.175	1: .30
			Average Nos. 1653 and 1664.....	0	.56	2.48	.264	.066	.198	1: .33
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	0	.34	1.60	.189	.052	.137	1: .38
1639	1637	107	Beef, round.....	0	.50	3.14	.309	.155	.154	1:1.01
1643	1647	110	.....do.....	0	.44	2.37	.288	.147	.141	1:1.04
1721	1722	132	.....do.....	0	.38	2.09	.297	.089	.208	1: .43
			Average.....	0	.44	2.53	.298	.130	.168	1: .77
1704	1705	126	Beef, rump.....	0	.47	2.62	.315	.144	.171	1: .84
1652	1656	114	Veal, leg.....	0	.73	3.96	.428	.070	.358	1: .20
			Average Nos. 1639, 1643, 1652, 1704, and 1721.....	0	.50	2.83	.327	.121	.206	1: .59
			Average of all cooked 5 hours...	0	.39	1.98	.225	.074	.151	1: .49
			Average of all cooked 3 or 5 hours.....	0	.44	2.17	.251	.060	.191	1: .31

TABLE 111.—*Chemical composition of cold-water extracts of meats cooked by boiling (water-free substance).*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Proteid.	Organic extractives.	
				At beginning.	During cooking.			Nitrogenous.	Nonnitrogenous.
1642	1640	109	Beef, round.....	°C. Cold.	°C. 85	Hours. 3	Per ct. 0.35	Per ct. 1.07	Per ct. 1.40
1754	1753	137	.....do.....	Cold.	85	3	.46	1.78	1.87
			Average.....				.40	1.43	1.64
1756	1753	139	Beef, round (browned).....	Cold.	85	3	.40	1.75	1.75
			Average Nos. 1642, 1754, and 1756.....				.40	1.53	1.67
1746	1741	136	Beef, round (browned).....	85	85	3	.35	1.68	2.09
1769	1764	145	Beef, round.....	85	85	3	.50	2.18	2.02
1780	1775	154	.....do.....	85	85	3	.29	1.79	2.05
			Average Nos. 1769 and 1780.....				.40	1.99	2.04
			Average Nos. 1746, 1769, and 1780.....				.38	1.88	2.05
1641	1640	108	Beef, round.....	100	85	3	.93	.81	1.10
1744	1741	134	.....do.....	100	85	3	.78	1.88	2.56
1768	1764	144	.....do.....	100	85	3	.51	2.40	3.11
1779	1775	153	.....do.....	100	85	3	.44	2.05	2.27
			Average.....				.67	1.79	2.26
1755	1753	138	Beef, round.....	Cold.	100	3	1.00	1.69	2.06
1757	1753	140	Beef, round (browned).....	Cold.	100	3	1.13	1.81	2.09
			Average.....				1.07	1.75	2.08
1743	1741	133	Beef, round.....	100	100	3	.78	1.82	2.46
1745	1741	135	Beef, round (browned).....	100	100	3	.57	1.68	1.85
			Average.....				.68	1.75	2.16
			Average of all cooked 3 hours.....				.61	1.74	2.05
1646	1647	113	Beef, round.....	Cold.	65	5	.73	.78	1.03
1645	1647	112	.....do.....	Cold.	85	5	.89	.80	1.07
1654	1656	116	Veal, leg.....	Cold.	85	5	1.89	.92	3.06
1658	1662	118	.....do.....	Cold.	85	5	.91	1.25	1.55
			Average.....				1.40	1.09	2.31
			Average Nos. 1645, 1654, and 1658.....				1.23	.99	1.89
1644	1647	111	Beef, round.....	100	85	5	.71	.98	1.39
1720	1722	131	.....do.....	100	85	5	.36	2.45	.34
			Average.....				.54	1.22	.87
1665	1668	121	Beef, neck.....	100	85	5	.42	.70	1.21
1673	1676	123	Beef, rump.....	100	85	5	.62	.76	.70
1703	1705	125	.....do.....	100	85	5	.74	.56	.66
			Average Nos. 1673 and 1703.....				.68	.66	.68
1669	1672	122	Beef, flank.....	100	85	5	.75	.07	.32
1653	1656	115	Veal, leg.....	100	85	5	1.47	2.07	3.00
1664	1662	117	.....do.....	100	85	5	.84	1.47	1.99
			Average Nos. 1653 and 1664.....				1.16	1.77	2.50
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....				.74	1.01	1.20

TABLE 111.—*Chemical composition of cold-water extracts of meats cooked by boiling (water-free substance)*—Continued.

Laboratory No.	Raw meat used, No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Proteid.	Organic extractives.	
				At beginning.	During cooking.			Nitrogenous.	Nonnitrogenous.
				°C.	°C.	Hours.	Per ct.	Per ct.	Per ct.
1639	1637	107	Beef, round .....	100	100	5	2.40	1.19	2.95
1643	1647	110	.....do .....	100	100	5	2.33	1.12	1.44
1721	1722	132	.....do .....	100	100	5	1.31	1.51	1.17
			Average .....				2.01	1.27	1.85
1704	1705	126	Beef, rump.....	100	100	5	2.00	1.18	1.60
1652	1656	114	Veal, leg .....	100	100	5	1.25	3.18	4.74
			Average Nos. 1639, 1643, 1652, 1704, and 1721 .....				1.86	1.63	2.38
			Average of all cooked 5 hours .....				1.16	1.18	1.66
			Average of all cooked 3 or 5 hours .....				.88	1.43	1.84

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Total extractives.	Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Non-proteid nitrogen.
				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1642	1640	109	Beef, round.....	2.47	0	0.67	3.49	0.399	0.053	0.346
1754	1753	157	.....do .....	3.65	0	1.25	5.36	.645	.073	.572
			Average .....	3.07	0	.96	4.43	.522	.063	.459
1756	1753	139	Beef, round (browned) ...	3.50	0	1.16	5.06	.626	.065	.561
			Average Nos. 1642, 1754, and 1756.....	3.20	0	1.03	4.64	.557	.064	.493
1746	1741	136	Beef, round (browned) ...	3.77	0	1.17	5.29	.597	.055	.542
1769	1764	145	Beef, round.....	4.20	0	1.46	6.16	.779	.080	.699
1780	1775	154	.....do .....	3.84	0	1.27	5.40	.617	.046	.571
			Average Nos. 1769, and 1780.....	4.03	0	1.37	5.78	.698	.063	.635
			Average Nos. 1746, 1769, and 1780.....	3.93	0	1.30	5.62	.664	.060	.604
1641	1640	108	Beef, round .....	1.91	0	.71	3.55	.411	.150	.261
1744	1741	134	.....do .....	4.44	0	1.26	6.48	.728	.124	.604
1768	1764	144	.....do .....	5.51	0	.79	6.81	.855	.082	.773
1779	1775	153	.....do .....	4.32	0	1.31	6.07	.724	.070	.654
			Average.....	4.05	0	1.02	5.73	.680	.107	.573
1755	1753	138	Beef, round.....	3.75	0	.96	5.71	.706	.161	.545
1757	1753	140	Beef, round (browned) ...	3.90	0	1.20	6.23	.763	.180	.583
			Average.....	3.83	0	1.08	5.97	.735	.171	.564
1743	1741	133	Beef, round .....	4.28	0	1.35	6.41	.707	.124	.583
1745	1741	135	Beef, round (browned) ...	3.53	0	1.19	5.29	.631	.091	.540
			Average.....	3.91	0	1.27	5.85	.669	.108	.561
			Average of all cooked 3 hours....	3.79	0	1.13	5.52	.657	.097	.560
1646	1647	113	Beef, round.....	1.81	0	.65	3.19	.372	.118	.254
1645	1647	112	.....do .....	1.87	0	.84	3.59	.401	.142	.250
1654	1656	116	Veal, leg .....	3.98	0	1.59	7.46	.602	.303	.299
1658	1662	118	.....do .....	2.80	0	1.13	4.84	.539	.142	.397
			Average .....	3.40	0	1.36	6.15	.571	.223	.348
			Average Nos. 1645, 1654, and 1658 .....	2.88	0	1.19	5.30	.514	.196	.318

TABLE 111.—*Chemical composition of cold-water extracts of meats cooked by boiling (water-free substance)*—Continued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Total extractives.	Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Non-proteid nitrogen.
				<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1644	1647	111	Beef, round.....	2.37	0	0.93	4.01	0.426	0.113	0.313
1720	1722	131	.....do.....	1.79	0	.57	2.72	.524	.057	.467
			Average.....	2.09	0	.75	3.37	.475	.085	.390
1665	1668	121	Beef, neck.....	1.91	0	.44	2.77	.290	.066	.224
1673	1676	123	Beef, rump.....	1.46	0	.41	2.49	.343	.099	.244
1703	1705	125	.....do.....	1.22	0	.54	2.50	.297	.118	.179
			Average Nos. 1673 and 1703.....	1.34	0	.48	2.50	.320	.109	.211
1669	1672	122	Beef, flank.....	.39	0	.37	1.51	.144	.118	.026
1653	1656	115	Veal, leg.....	5.07	0	1.80	8.34	.903	.237	.666
1664	1662	117	.....do.....	3.46	0	1.39	5.09	.595	.135	.460
			Average Nos. 1653 and 1664.....	4.27	0	1.60	7.02	.749	.186	.563
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	2.21	0	.81	3.76	.440	.118	.322
1639	1637	107	Beef, round.....	4.14	0	1.24	7.78	.766	.384	.382
1643	1647	110	.....do.....	2.56	0	1.11	6.00	.730	.372	.358
1721	1722	132	.....do.....	2.68	0	.90	4.89	.694	.208	.486
			Average.....	3.12	0	1.08	6.22	.730	.321	.409
1704	1705	126	Beef, rump.....	2.78	0	1.04	5.82	.699	.320	.379
1652	1656	114	Veal, leg.....	7.92	0	2.07	11.24	1.215	.199	1.016
			Average Nos. 1639, 1643, 1652, 1704, and 1721.....	4.01	0	1.27	7.15	.821	.297	.524
			Average of all cooked 5 hours.....	2.84	0	1.00	5.00	.561	.184	.377
			Average of all cooked 3 or 5 hours.....	3.27	0	1.06	5.23	.604	.145	.459

The data reported show that the cold-water extract of 31 samples of boiled beef and veal contained on an average 0.38 per cent proteid, 0.60 per cent nitrogenous extractives, 0.75 per cent nonnitrogenous extractives, 1.35 per cent organic extractives, and 0.44 per cent of mineral matter, making a total of 2.17 per cent soluble matter. The total nitrogen averaged 0.251 per cent, of which 0.060 per cent existed as soluble proteid and 0.191 per cent as nonproteid nitrogen. The ratio of nonproteid to proteid nitrogen was 1:0.31. Comparison of these figures with those on page 127 indicate that boiled meat is by no means as soluble in cold water as raw. It must be remembered, however, that these figures for the solubility of uncooked and boiled meats as reported are not directly comparable, since the uncooked meats contain much more water than do the cooked meats. It will therefore be more satisfactory to consider the results as calculated to a water-free basis. When the results are thus stated (see Table 111, p. 132), we find that cold water removed from the 31 samples of boiled flesh on an average 0.88 per cent proteid, 1.43 per cent nitrogenous extractives, 1.84 per cent nonnitrogenous extractives, 3.27 per cent organic

extractives, and 1.06 per cent ash, making in all 5.23 per cent soluble material. Upon the same basis, the amount of total nitrogen dissolved by cold water from the boiled meats averaged 0.604 per cent, of which 0.145 per cent existed as proteid and 0.459 per cent as non-proteid nitrogen.

In the case of raw meats the average values for samples on a water-free basis (see Table 109, p. 127) are: 8.39 per cent proteid, 3.98 per cent nitrogenous extractives, 5.94 per cent nonnitrogenous extractives, 9.92 per cent total organic extractives, 3.09 per cent ash, or 21.41 per cent total soluble matter. The average percentage of total nitrogen dissolved by cold water from the raw meats was 2.621, of which 1.343 existed as proteid nitrogen and 1.278 as nonproteid nitrogen.

These results show plainly that boiled meats are much less soluble in cold water than similar cuts of raw meat, the total nutrients of raw meats being 4.7 times more soluble in cold water than the nutrients of meats cooked in hot water. As regards the individual constituents, the proteids of raw meats are 9.5 times more soluble in cold water than are the proteids of boiled meats. The nitrogenous and nonnitrogenous extractives of both raw and cooked meats are completely soluble in water, but the cold-water extracts of uncooked meats contain three times as great a quantity of these substances as do the cold-water extracts of boiled meats, calculated to the water-free basis. The cold-water extracts of uncooked meats contain three times as much ash and 4.3 times more total nitrogen, 9.2 times more proteid nitrogen, and 2.8 times more nonproteid nitrogen than do cold-water extracts of meats cooked in hot water.

By comparing the data here presented regarding each individual nutrient in the cold-water extracts of meats cooked by boiling with the results of the complete analysis of the cooked meats as given in Table No. 100, it will be found that only 1.19 per cent of the total proteid existing in the cooked meat was soluble in cold water, while in the case of the raw meats 12.86 per cent of the total proteid was in a soluble form. As in the case of the uncooked meats, all of the nitrogenous and nonnitrogenous extractives of the boiled meats were found to be soluble, while none of the fat of the flesh entered into solution. A considerable proportion of the ash of the boiled meat was soluble in water, the average being 66.67 per cent as compared with 80.58 per cent for 11 samples of raw beef.

The total nutrients soluble in cold water, expressed as per cent of the total nutrients in the boiled meats, varies from 1.47 in beef flank (sample No. 1669) to 10.87 per cent in the case of veal leg (sample No. 1652), the average being 5.02 per cent. In other words, these experiments indicate that on an average one-twentieth of the total nutrients of the cooked meat are soluble in cold water. In the raw meats the total nutrients soluble in cold water form 18.46 per cent or about one-fifth of the total nutrients originally present.



The average results of the 31 analyses of the meats cooked in hot water indicate that the solid matter obtained by extraction with cold water contains 11.57 per cent nitrogen, 17.51 per cent proteid, 27.65 per cent nitrogenous extractives, 34.56 per cent nonnitrogenous extractives, and 20.28 per cent ash. The corresponding data for the raw meats were as follows: 12.25 per cent nitrogen, 39.34 per cent proteid, 18.56 per cent nitrogenous extractives, 27.84 per cent non-nitrogenous extractives, and 14.26 per cent ash.

In the case of boiled meat the soluble matter of the cold-water extract contains much less proteid matter and considerably greater quantities of nitrogenous and nonnitrogenous extractives and ash than in the case of raw meats.

It is evident from the data here given, that in the cold-water extracts of meats cooked in hot water, the proportion of proteid and the non-proteid nitrogen is quite unlike that in the cold-water extracts of uncooked meats. In the former the ratio of nonproteid to proteid nitrogen is 1:0.31 and in the latter 1:1.05.

In discussing the chemical composition of meats cooked by boiling (p. 113), the conclusion was reached that there were no marked or important differences in the chemical composition and nutritive value of meats which had been cooked in hot water by different methods. The data obtained in the study of the chemical composition of the cold-water extracts of the boiled meats furnish some additional information on this point, and the following table gives a summary of the averages of the results obtained in the analyses of the cold-water extracts of meats cooked in hot water by different methods:

TABLE 112.—*Summary showing the chemical composition of cold-water extracts of meats cooked by different methods of boiling.*

Method of cooking.	Average of.	Temperature.		Duration of cooking.	Proteid.	Organic extractives.			Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Nonproteid nitrogen.	Ratio of nonproteid to proteid nitrogen.
		At beginning.	During cooking.			Nitrogenous.	Nonnitrogenous.	Total.							
		°C.	°C.	Hrs.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	
Boiled .....	3	Cold.	85	3	0.17	0.65	0.71	1.36	0	0.44	1.97	0.237	0.027	0.210	1:0.13
Do. ....	3	85	85	3	.16	.83	.90	1.73	0	.57	2.46	.292	.026	.266	1: .10
Do. ....	4	100	85	3	.28	.76	.96	1.72	0	.44	2.44	.290	.045	.245	1: .18
Do. ....	10		85	3	.21	.75	.87	1.62	0	.48	2.31	.275	.034	.241	1: .14
Do. ....	2	Cold.	100	3	.47	.77	.90	1.67	0	.47	2.61	.321	.074	.247	1: .30
Do. ....	2	100	100	3	.29	.75	.91	1.66	0	.54	2.49	.285	.046	.239	1: .19
Do. ....	4		100	3	.38	.76	.91	1.67	0	.51	2.55	.303	.060	.243	1: .25
Boiled, 3 hours.	14			3	.26	.75	.88	1.63	0	.49	2.38	.283	.042	.241	1: .17
Do. ....	1	Cold.	65	5	.27	.29	.38	.67	0	.24	1.18	.138	.044	.094	1: .47
Do. ....	3	Cold.	85	5	.42	.35	.65	1.00	0	.41	1.83	.180	.067	.113	1: .60
Do. ....	8	100	85	5	.33	.43	.50	.93	0	.34	1.60	.189	.052	.137	1: .38
Do. ....	11		85	5	.35	.41	.54	.95	0	.36	1.66	.187	.056	.131	1: .44
Do. ....	5	100	100	5	.76	.64	.93	1.57	0	.50	2.83	.327	.121	.206	1: .59
Boiled, 5 hours.	17			5	.47	.47	.65	1.12	0	.39	1.98	.225	.074	.151	1: .49
Boiled, 3 and 5 hours	31				.38	.60	.75	1.35	0	.44	2.17	.251	.060	.191	1: .31
Uncooked .....	13				2.30	10.9	1.63	2.72	0	.85	5.87	.719	.369	.350	1:1.05

It is evident from the data in Table 112, that the differences between the chemical composition of the cold-water extracts of meats cooked by different methods of boiling are much less than those which exist between boiled meats and raw meats. There appear to be, however, slight differences in the case of meats cooked for three and for five hours. The average composition of the cold-water extracts of 14 samples of meats cooked for three hours was 0.26 per cent proteid, 0.75 per cent nitrogenous extractives, 0.88 per cent nonnitrogenous extractives, 1.63 per cent total organic extractives, 0.49 per cent ash, and 2.38 per cent total soluble matter. The total nitrogen dissolved by cold water averaged 0.283 per cent, of which 0.042 per cent existed as proteid and 0.241 per cent as nonproteid nitrogen. The ratio of nonproteid to proteid nitrogen, was 1:0.17. The average composition of the cold-water extracts of the 17 samples of meats which had been cooked for five hours was as follows: 0.47 per cent proteid, 0.47 per cent nitrogenous extractives, 0.65 per cent non-nitrogenous extractives, 1.12 per cent total organic extractives, 0.39 per cent ash, and 1.98 per cent total soluble material. The total dissolved nitrogen averaged 0.225 per cent, of which 0.074 per cent was proteid and 0.151 per cent nonproteid nitrogen, the ratio of nonproteid to proteid nitrogen being 1:0.49. These results show that the meats cooked for the longer time in hot water contained almost twice as much soluble proteid, but only about two-thirds as much total organic extractives, and four-fifths as much ash and total soluble material as those cooked for the shorter period. The differences in the composition of the cold-water extracts of meats cooked at different temperatures are so slight (see Table 110) that it is not deemed necessary to consider them in detail here.

In conclusion it may be said that the analyses of the cold-water extracts of boiled meats confirm the deduction made from the data regarding their chemical composition, namely, that the different methods commonly used in cooking meats in hot water cause only slight variations in the composition and solubility, and hence in nutritive value and flavor of the resulting product.

#### COMPOSITION OF THE COLD-WATER EXTRACTS OF MEATS COOKED BY ROASTING, BROILING, SAUTÉING, AND FRYING.

The results of the analysis of the cold-water extracts of meats which were cooked by roasting, broiling, sautéing, and frying are summarized in Tables 113 and 114.

TABLE 113.—*Chemical composition of cold-water extracts of meats cooked by roasting, broiling, sautéing, and frying (fresh substance).*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat and method of cooking.	Organic extractives.				Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Nonproteid nitrogen.	Ratio of nonproteid to proteid nitrogen.
				Proteid.	Nitrogenous.	Nonnitrogenous.	Total.							
1770	1764	146	Beef, round, pot roast	<i>P. ct.</i> 0.31	<i>P. ct.</i> 1.40	<i>P. ct.</i> 1.69	<i>P. ct.</i> 3.09	<i>P. ct.</i> 0	<i>P. ct.</i> 0.84	<i>P. ct.</i> 4.24	<i>P. ct.</i> 0.498	<i>P. ct.</i> 0.050	<i>P. ct.</i> 0.448	1: 0.14
1781	1775	155	.....do.....	.42	1.11	1.17	2.28	0	.83	3.53	.421	.067	.354	1: .19
			Average.....	.37	1.26	1.43	2.69	0	.83	3.89	.460	.059	.401	1: .15
1771	1764	147	Beef, round, roast....	.75	1.36	1.55	2.91	0	.96	4.62	.557	.119	.438	1: .27
1782	1775	156	.....do.....	1.23	.94	1.27	2.21	0	.95	4.39	.497	.197	.300	1: .66
			Average.....	.99	1.15	1.41	2.56	0	.96	4.51	.527	.158	.369	1: .43
1660	1662	120	Veal, leg, roast.....	.41	1.34	1.89	3.23	0	1.18	4.82	.496	.066	.430	1: .15
			Average Nos. 1660, 1771 and 1782.....	.80	1.21	1.57	2.78	0	1.03	4.61	.517	.128	.389	1: .33
1778	1775	152	Beef, round, gas broiled.....	.83	1.38	1.62	3.00	0	1.01	4.84	.575	.133	.442	1: .30
1766	1764	142	Beef, round, pan broiled.....	1.37	1.46	1.72	3.18	0	.99	5.54	.686	.219	.467	1: .47
1777	1775	151	.....do.....	.58	1.48	1.72	3.20	0	1.05	4.83	.569	.094	.475	1: .20
			Average Nos. 1766 and 1777.....	.98	1.47	1.72	3.19	0	1.02	5.19	.628	.156	.472	1: .33
1674	1676	124	Beef, rump, pan broiled.....	.27	1.07	1.33	2.40	0	1.07	3.74	.387	.044	.343	1: .13
1659	1662	119	Veal, leg, pan broiled.....	.42	1.33	1.84	3.17	0	1.29	4.88	.494	.068	.426	1: .16
			Average Nos. 1659, 1674, 1766 and 1777.....	.66	1.34	1.65	2.99	0	1.10	4.75	.534	.106	.428	1: .25
1765	1764	141	Beef, round, sautéed.	1.03	1.38	1.69	3.07	0	.94	5.04	.608	.165	.443	1: .37
1776	1775	150	.....do.....	.73	1.37	1.61	2.98	0	.95	4.66	.556	.116	.440	1: .26
			Average.....	.88	1.38	1.65	3.03	0	.94	4.85	.582	.141	.441	1: .32
1767	1764	143	Beef, round, fried....	.53	1.62	1.83	3.45	0	1.09	5.07	.605	.086	.519	1: .17
			Average of all beef samples.	.73	1.33	1.56	2.89	0	.97	4.59	.542	.117	.425	1: .28
			Average of all veal samples.	.41	1.34	1.87	3.21	0	1.23	4.85	.495	.067	.428	1: .16
			Average of all beef and veal samples.....	.68	1.33	1.61	2.94	0	1.01	4.63	.535	.109	.426	1: .26

TABLE 114.—*Chemical composition of cold-water extracts of meats cooked by roasting, broiling, sautéing, and frying (water-free substance).*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat and method of cooking.	Organic extractives.				Fat.	Ash.	Total solid matter.	Total nitrogen.	Proteid nitrogen.	Nonproteid nitrogen.
				Proteid.	Nitrogenous.	Non nitrogenous.	Total.						
				P. ct.	P. ct.	P. ct.	Perct.	Perct.	Perct.	Perct.	Perct.	Perct.	Perct.
1770	1764	146	Beef, round, pot roast.	0.65	2.91	3.52	6.43	0	1.75	8.83	1.036	0.105	0.931
1781	1775	155	.....do .....	.89	2.36	2.49	4.85	0	1.76	7.50	.895	.142	.753
			Average .....	.77	2.64	3.01	5.65	0	1.75	8.17	.966	.124	.842
1771	1764	147	Beef, round, roast....	2.10	3.84	4.38	8.22	0	2.71	13.03	1.574	.338	1.236
1782	1775	156	.....do .....	3.91	2.99	4.04	7.03	0	3.02	13.96	1.582	.626	.956
			Average .....	3.01	3.42	4.21	7.63	0	2.86	13.50	1.578	.482	1.096
1660	1662	120	Veal, leg, roast.....	1.30	4.23	5.97	10.20	0	3.73	15.23	1.566	.210	1.356
			Average Nos. 1660, 1771, and 1782.....	2.44	3.69	4.79	8.48	0	3.15	14.07	1.574	.391	1.183
1778	1775	152	Beef, round, gas broiled .....	2.46	4.09	4.80	8.89	0	2.99	14.34	1.705	.393	1.312
1763	1764	142	Beef, round, pan broiled .....	3.98	4.25	5.00	9.25	0	2.88	16.11	1.996	.636	1.360
1777	1775	151	.....do .....	1.69	4.32	5.02	9.34	0	3.07	14.10	1.662	.273	1.389
			Average .....	2.84	4.29	5.01	9.30	0	2.97	15.11	1.829	.455	1.374
1674	1676	124	Beef, rump, pan broiled .....	.37	1.48	1.83	3.31	0	1.48	5.16	.534	.060	.474
1659	1662	119	Veal, leg, pan broiled.	1.21	3.84	5.31	9.15	0	3.72	14.08	1.425	.196	1.229
			Average Nos. 1659, 1674, 1766, and 1777.....	1.81	3.47	4.29	7.76	0	2.79	12.36	1.404	.291	1.113
1765	1764	141	Beef, round, sautéed..	2.87	3.84	4.70	8.54	0	2.62	14.03	1.690	.459	1.231
1776	1775	150	.....do .....	2.19	4.11	4.83	8.94	0	2.85	13.98	1.667	.347	1.320
			Average .....	2.53	3.98	4.77	8.75	0	2.73	14.01	1.679	.403	1.276
1767	1764	143	Beef, round, fried ....	1.26	3.84	4.33	8.17	0	2.58	12.01	1.433	.203	1.230
			Average of all beef samples..	2.04	3.46	4.09	7.55	0	2.52	12.11	1.434	.326	1.108
			Average of all veal samples..	1.26	4.04	5.64	9.68	0	3.73	14.67	1.496	.203	1.293
			Average of all beef and veal samples.....	1.92	3.55	4.33	7.88	0	2.71	12.51	1.444	.307	1.137

The cold-water extract from the 13 samples of beef and veal cooked by dry heat contained on an average 0.68 per cent proteid, 1.33 per cent nitrogenous extractives, 1.61 per cent nonnitrogenous extractives, 2.94 per cent total organic extractives, and 1.01 per cent mineral matter, making a total of 4.63 per cent soluble matter. The total nitrogen averaged 0.535 per cent, of which 0.109 per cent was present as proteid, and 0.426 per cent as nonproteid nitrogen. The ratio of nonproteid to proteid nitrogen was 1:0.26.

As will be seen by comparison of these figures with those for raw meat and for boiled meat given on pages 127 and 129, the meats cooked

by dry heat contain less soluble material than raw meats but more soluble constituents than boiled meats. It is, however, more satisfactory to compare the results on a water-free basis. Stated in this form (see Table 114), cold water extracted on an average from the 13 samples of meats cooked by dry heat 1.92 per cent proteid, 3.55 per cent nitrogenous extractives, 4.33 per cent nonnitrogenous extractives, 7.88 per cent total organic extractives, 2.71 per cent ash, and 12.51 per cent total soluble matter.

The corresponding data for the raw and for boiled meats have already been given (see Tables 109 and 111, pp. 127 and 132). From the experimental data thus presented it is evident that meats cooked by dry heat are 2.4 times as soluble as boiled beef, but only a little more than one-half as soluble as raw meats. The chief differences in the solubility of meats cooked by roasting, etc., and raw meats is due to the much smaller content of soluble proteid matter, which is 6.38 per cent less than in the raw meat. Meats cooked by dry heat also contain on an average 2.04 per cent less of total organic extractives and 0.38 per cent less ash.

It is also apparent from the data presented in Tables 111 and 114 that the water-free substance of roast meats contains about 2.3 as much soluble proteids and nonnitrogenous extractives and 2.5 as much nitrogenous extractives and ash as the water-free substance of boiled meats. The more pronounced flavor of meats cooked by dry heat as compared with those cooked in hot water is without doubt due to these additional soluble constituents.

In the light of our present knowledge the cooked meats containing this greater amount of soluble organic and inorganic substances must be considered somewhat more nutritious and palatable.

These conclusions are in accord with the opinion commonly held, namely, that roast meats and meats cooked in other ways by dry heat are more savory and nutritious than boiled meats. If the broth from boiled meat is used as soup, gravy or otherwise, of course the total nutritive value of the meat is retained, and the boiled meat with the soup surpasses the roast. The factors which influence palatability are also to be considered, and here the advantage is with the meat cooked by dry heat. From a practical standpoint the differences in the nutritive value of meats cooked by dry heat and those cooked in hot water are not great enough to be of much importance, though as regards qualities which make up flavor the roast meat surpasses the boiled.

Tables 115 and 116, which follow, summarize the data regarding the composition of the cold-water extracts of raw meat, boiled meat, and meat cooked by dry heat.



TABLE 115.—Average composition of the cold-water extracts of uncooked, boiled, and dry-cooked meats (expressed in percentage of the weight of meat taken).

Kind of meat and method of cooking.	No. in average.	Proteid.	Organic extractives.			Fat.	Ash.	Total solid matter.	Nitrogen.			Ratio of non-proteid to proteid nitrogen.
			Ni-trogenous.	Non-ni-trogenous.	Total.				Proteid.	Non-proteid.	Total.	
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	
Beef, uncooked .....	11	2.29	1.08	1.62	2.70	0	0.83	5.82	0.367	0.346	0.713	1: 1.06
Veal, uncooked .....	2	2.37	1.17	1.66	2.83	0	.95	6.15	.378	.375	.753	1: 1.01
Beef, boiled three hours	14	.26	.75	.88	1.63	0	.49	2.38	.042	.241	.283	1: .17
Beef, boiled five hours	17	.47	.47	.65	1.12	0	.39	1.98	.074	.151	.225	1: .49
Beef, boiled three and five hours	31	.38	.60	.75	1.35	0	.44	2.17	.060	.191	.251	1: .31
Beef, pot roast .....	2	.37	1.26	1.43	2.69	0	.83	3.89	.059	.401	.460	1: .15
Beef, roast .....	2	.99	1.15	1.41	2.56	0	.96	4.51	.158	.369	.527	1: .43
Veal, roast .....	1	.41	1.34	1.89	3.23	0	1.18	4.82	.066	.430	.496	1: .15
Beef, gas broiled .....	1	.83	1.38	1.62	3.00	0	1.01	4.84	.133	.442	.575	1: .30
Beef, pan broiled .....	3	.74	1.34	1.59	2.93	0	1.04	4.71	.119	.429	.548	1: .26
Veal, pan broiled .....	1	.42	1.33	1.84	3.17	0	1.29	4.88	.068	.426	.494	1: .16
Beef, sautéed .....	2	.88	1.38	1.65	3.03	0	.94	4.85	.141	.441	.582	1: .32
Beef, fried .....	1	.53	1.62	1.83	3.45	0	1.09	5.07	.086	.519	.605	1: .17

TABLE 116.—Average composition of the cold-water extracts of uncooked, boiled, and dry-cooked meats (water-free substance).

Kind of meat and method of cooking.	No. in average.	Proteid.	Organic extractives.			Fat.	Ash.	Total solid matter.	Nitrogen.		
			Ni-trogenous.	Non-ni-trogenous.	Total.				Proteid.	Non-proteid.	Total.
			<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
Beef, uncooked .....	11	8.14	3.83	5.78	9.61	0	2.94	20.69	1.303	1.229	2.532
Veal, uncooked .....	2	9.77	4.83	6.84	11.67	0	3.94	25.38	1.564	1.544	3.108
Beef, boiled three hours	14	.61	1.74	2.05	3.79	0	1.13	5.52	.097	.560	.657
Beef, boiled five hours	17	1.16	1.18	1.66	2.84	0	1.00	5.00	.184	.377	.561
Beef, boiled three and five hours	31	.88	1.43	1.84	3.27	0	1.06	5.23	.145	.459	.604
Beef, pot roast .....	2	.77	2.64	3.01	5.65	0	1.75	8.17	.124	.842	.966
Beef, roast .....	2	3.01	3.42	4.21	7.63	0	2.86	13.50	.482	1.096	1.578
Veal, roast .....	1	1.30	4.23	5.97	10.20	0	3.73	15.23	.210	1.356	1.566
Beef, gas broiled .....	1	2.46	4.09	4.80	8.89	0	2.99	14.34	.393	1.312	1.705
Beef, pan broiled .....	3	2.02	3.35	3.95	7.30	0	2.47	11.79	.323	1.074	1.397
Veal, pan broiled .....	1	1.21	3.84	5.31	9.15	0	3.72	14.08	.196	1.229	1.425
Beef, sautéed .....	2	2.53	3.98	4.77	8.75	0	2.73	14.01	.403	1.276	1.679
Beef, fried .....	1	1.26	3.84	4.33	8.17	0	2.58	12.01	.203	1.230	1.433

## THE AMOUNT AND NATURE OF THE NITROGENOUS CONSTITUENTS OF UNCOOKED AND COOKED MEATS.

In a study of the chemistry of the digestion of meats, and the nutritive value of flesh foods, it is highly desirable that the present very limited knowledge of the nitrogenous principles as they exist in raw and cooked meats be extended.

Such a study is difficult for several reasons. In the first place, a considerable number of the nitrogenous constituents of flesh are as yet unidentified as individual and characteristic compounds, and the data regarding the physical and chemical properties of those which are known are very incomplete and contradictory. In the second place, the methods for the qualitative and quantitative separation and estimation of the various nitrogenous bodies known to exist in animal substances are very far from satisfactory.

In recent years much attention has been directed to the study of the chemical structure of proteids of animal and vegetable origin, especially as shown by the number and nature of the cleavage products obtained by the action of different reagents. In this connection the animal proteids are of especial interest. They have been found to vary very greatly in complexity from scombrin, obtained from the reproductive organs of mackerel, which, according to Kossel and Dakin,<sup>a</sup> yields only three or four cleavage products, to such bodies as casein, globin, etc. According to E. Fischer's<sup>b</sup> investigations, casein yields 16 cleavage products and in globin, a body isolated from the oxyhemoglobin of horse blood, Abderhalden<sup>c</sup> has identified 14 cleavage products. Some of the proteids studied are of importance from the standpoint of nutrition, while others are not of so great interest in this connection; but as a whole such studies are of undoubted value because of the data they provide regarding the chemical nature of nitrogenous foods, and it is fortunate that so many chemists are turning their attention to these problems.

In their study of the relative merits of white and red meat in invalid dietetics, Offer and Rosenquist<sup>d</sup> determined the total nitrogen, nitrogen of extractives, and nitrogen of meat bases in a large number of samples of fish, poultry, veal, pork, beef, mutton, venison, and salted and smoked meats. In some cases analyses were made with cooked samples, but in most cases with the raw meat. The smallest proportion of total nitrogen, 2.54 per cent, was reported in a sample of pork; the highest, 4.09 per cent, in dried beef. The majority of the samples contained from 0.4 to 0.5 per cent nitrogen of extractives. Less than 0.4 per cent was noted in samples of boiled beef (soup meat), fillet of beef, pork, and chicken, and over 0.5 per cent in pike, perch, scraped beef, and raw and cooked ham. In the case of nitrogen of meat bases the largest proportions, 0.071, 0.056, and 0.05 per cent, were reported in scraped beef, pork, and boiled beef (soup meat), respectively, and the smallest proportions, 0.009 and 0.007 per cent, respectively, in venison and pike.

E. Zunz<sup>e</sup> studied some of the constituents of veal. When 5 kilograms of lean veal, taken three-quarters of an hour after the calf was slaughtered, was boiled, 0.679 gram histidin, 0.138 gram arginin, 0.559 gram lysin, 0.227 gram leucin, 0.662 gram glutaminic acid, and 0.371 gram aspartic acid were recovered.

<sup>a</sup> Ztschr. Physiol. Chem., 44 (1905), p. 342. See also Kossel, *Ibid.*, p. 347.

<sup>b</sup> Ztschr. Physiol. Chem., 33 (1901), p. 151.

<sup>c</sup> Ztschr. Physiol. Chem., 37 (1903), p. 499.

<sup>d</sup> Berlin. Klin. Wehnschr., 36 (1899), pp. 937, 968, 1086.

<sup>e</sup> Ann. Soc. Roy. Sci. Méd. et Nat. Bruxelles, 13 (1904); abs. in Zentbl. Physiol., 18 (1904), p. 852.

In connection with the investigations here reported it was believed that a study of the nature and amount of the nitrogenous constituents of raw and cooked meat, which are ordinarily regarded as of particular importance in discussions of nutritive value, would prove useful, and so an investigation of this sort was undertaken.

The methods used to obtain the figures quoted have already been described (pp. 13-15). The results of the experimental work are given below.

### FORMS OF NITROGEN IN UNCOOKED MEATS.

The data regarding the form in which nitrogen occurs in the cold-water extract of raw meat are summarized in Tables 117-119. Table 117, showing the data calculated on the basis of the total weight of the meat, follows.

TABLE 117.—*Nitrogen records of the cold-water extracts of raw meats (results expressed in percentage of meat taken).*

Laboratory No.	Cooking experiment No.	Kind of meat.	Total nitrogen in meat.	Total nitrogen in water extract.	Nitrogen coagulated by heat.	Nitrogen precipitated by $\text{ZnSO}_4$ (albumoses).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromine in filtrate from $\text{ZnSO}_4$ .	Proteid nitrogen in water extract.
			<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1672	122	Beef, flank, raw .....	2.479	0.4401	0.1744	0.0122	0.1866	0.0072	0.1938
1668	121	Beef, neck, raw .....	3.098	.6266	.3416	.0214	.3630	.0052	.3682
1637	107	Beef, round, raw .....	3.390	.7896	a. 0416	a. 4004	.4420	.....	.4420
1640	108-109	.....do .....	3.580	.8832	a. 0602	a. 3831	.4433	.....	.4433
1647	110-113	.....do .....	3.350	.7440	.2221	.0609	.2830	.0088	.2918
1722	131-132	.....do .....	3.392	.7913	.3996	.0327	.4323	.....	.4323
1741	133-136	.....do .....	3.424	.8457	.4105	.0375	.4480	.....	.4480
1753	137-140	.....do .....	3.433	.7391	.3586	.0244	.3830	.....	.3830
1764	141-147	.....do .....	3.251	.8105	.4048	.0276	.4324	.....	.4324
1775	150-156	.....do .....	3.349	.7142	.3366	.0154	.3520	.....	.3520
		Average Nos. 1637, 1640, 1647, 1722, 1741, 1753, 1764, and 1775.....	3.396	.7897	.3554	.0331	.4021	.0088	a. 4031
1676	123-124	Beef, rump, raw .....	2.400	.4560	.2233	.0200	.2432	.0027	.2459
		Average of all beef samples .....	3.195	.7128	.3191	.0280	a. 3645	b. 0060	a. 3665
1656	114-116	Veal, leg, raw .....	3.470	.8549	.3963	.0437	.4400	.0120	.4520
1662	117-120	.....do .....	3.230	.6503	.2644	.0238	.2882	.0150	.3032
		Average .....	3.350	.7526	.3303	.0388	.3641	.0135	.3776
		Average of all beef and veal samples .....	3.219	.7189	.3211	.0290	.3644	c. 0085	.3682

a Not included in average.

b Average of 3 analyses.

c Average of 5 analyses.

TABLE 117.—*Nitrogen records of the cold-water extracts of raw meats (results expressed in percentage of meat taken)*—Continued.

Laboratory No.	Cooking experiment No.	Kind of meat.	Non-proteid nitrogen in water extract	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen as ammonia.
			<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1672	122	Beef, flank, raw .....	0.1463	0.1903	0.2114	0.2286	0.2516	.....	0.0105
1668	121	Beef, neck, raw .....	.2584	.2129	.2948	.2978	.3205	.....	.0410
1637	107	Beef, round, raw .....	.3476	.....	.....	.3785	.3970	.....	.....
1640	108-109	.....do .....	.4399	.....	.....	.4817	.4622	.....	.....
1647	110-113	.....do .....	.4522	.....	.....	.3706	.3600	.....	.0005
1722	131-132	.....do .....	.3590	.....	.4129	.3940	.3970	0.3318	.1810
1741	133-136	.....do .....	.3977	.....	.4274	.4505	.4426	.2368	.0162
1753	137-140	.....do .....	.3561	.....	.4181	.3718	.3735	.3988	.0161
1764	141-147	.....do .....	.3781	.....	.4437	.4210	.4120	.4613	.0148
1775	150-156	.....do .....	.3622	.....	.3790	.3492	.3803	.3876	.0139
		Average Nos. 1637, 1640, 1647, 1722, 1741, 1753, 1764, and 1775 .....	.3866	.....	a. 4154	.4022	.4031	a. 3632	b. 0404
1676	123-124	Beef, rump, raw .....	.2100	.1834	.2206	.2231	.2258	.....	.0122
		Average of all beef samples .....	.3462	c. 1955	d. 3505	.3606	.3657	a. 3633	.0340
1656	114-116	Veal, leg, raw .....	.4029	.3704	.3888	.4418	.4192	.....	.0134
1662	117-120	.....do .....	.3471	.2257	.2350	.2897	.2534	.....	.0199
		Average .....	.3750	.2981	.3119	.3658	.3363	.....	.0167
		Average of all beef and veal samples .....	.3506	c. 2365	e. 3428	.3614	.3612	a. 3633	.0309

*a* Average of 5 analyses.*b* Average of 6 analyses.*c* Average of 3 analyses.*d* Average of 8 analyses.*e* Average of 10 analyses.

It will be seen that the total nitrogen in the uncooked meats (beef and veal) varies from 2.400 per cent in very fat beef rump (sample No. 1676) to 3.580 per cent in lean beef round (sample No. 1640), the average for 13 samples of uncooked meat being 3.219 per cent.

The total nitrogen soluble in cold water formed 0.4401 to 0.8832 per cent of the weight of the meat. The lowest figures were obtained with sample No. 1672, very fat beef flank, and the highest as before, with sample No. 1640, lean beef round. It will be observed further that the water-soluble nitrogen bears a direct relation to the total nitrogen in the meat. In other words, the more nitrogen there is in the meat the greater is the amount which will be dissolved by cold water. The average figures for nitrogen of compounds soluble in cold water are 0.7128 per cent for 11 samples of beef, and 0.7526 per cent for 2 samples of veal, the average for the beef and veal together being 0.7189 per cent.

The nitrogen in the form of proteids coagulable by heat in neutral solution varied from 0.1744 per cent in the beef flank (sample No. 1672), to 0.4105 per cent in a sample of beef round (No. 1741), the average for the raw meats being 0.3211 per cent of the entire weight of the fresh meats. The albumose nitrogen, as determined by precipita-

tion with zinc sulphate, was, as a rule, less than one-tenth of the nitrogen coagulated by heat. The average found in the 11 samples of fresh beef was 0.0280 per cent, and in the 2 samples of veal 0.0388 per cent.

In a few of the raw meats the nitrogen in the form of peptones was determined by treating with bromin the filtrate from the zinc sulphate precipitate. Only a very small amount of precipitate was obtained, the average quantity in the six tests being 0.0085 per cent. It has recently been fully demonstrated<sup>a</sup> that the use of bromin as a precipitant for proteids can not be relied upon.

For the time being we have assumed that the sum of the nitrogen coagulated by heat and that precipitated as albumoses by zinc sulphate represents the total soluble proteid nitrogen, except that in the cases where bromin has been used as a reagent the nitrogen thus precipitated has also been included in the proteid nitrogen. Investigations made in this laboratory lead to the belief that neither of these methods gives entirely trustworthy results, but that for the time being the first is in all probability the better method, notwithstanding the fact that the filtrate from the zinc sulphate precipitate still contains traces of nitrogen in the form of proteid. While the results thus obtained for the soluble proteid nitrogen can not be considered final and conclusive, they undoubtedly approximate the truth, and there is no doubt that by the careful use of these methods comparable results may be obtained.

The nitrogen of soluble proteid in the uncooked meats analyzed varied from 0.1938 per cent in beef flank (sample No. 1672) to 0.4520 per cent in veal leg (sample No. 1656), the average for the 13 samples of raw beef and veal being 0.3682 per cent. The nitrogen in the form of nonproteid substances is quite similar in amount to the nitrogen of the soluble proteids, and apparently varies directly as the latter. The nonproteid nitrogen varied from 0.1463 to 0.4522 per cent of the weight of the raw meats, the average for the 13 samples of beef and veal being 0.3506 per cent.

The data obtained indicate that there is a small amount of nitrogen invariably present in the form of ammonia or ammonium salts in cold-water extracts of raw flesh. This has been found to be true even where barium carbonate was used to remove the ammonia by distillation.

As pointed out by C. Mai,<sup>b</sup> the ratio of ammonia nitrogen to total nitrogen increases after meat has been hung for three or four days.

It is expected that a discussion of the relative value of bromin, phosphotungstic acid, tannin, and Stutzer's reagent for the estimation and separation of proteid and nonproteid substances will be considered in some detail in another publication from this laboratory, the dis-

<sup>a</sup> U. S. Dept. Agr., Bureau of Chemistry Bul. 81, pp. 104, 117, and 228.

<sup>b</sup> Ztschr. Untersuch. Nahr. u. Genussmtl., 4 (1901), No. 1, p. 18.



tinctly chemical work connected with the cooperative investigations with meat having been carried on for the University of Illinois. It will be sufficient at this time to say that these reagents precipitated from cold-water extracts of raw meats the following average quantities of nitrogen, expressed in percentage of the weight of fresh flesh taken: Bromin, 0.2365 per cent; phosphotungstic acid in a hot solution, 0.3428 per cent; phosphotungstic acid in a cold solution, 0.3612 per cent; tannin and salt, 0.3614 per cent, and Stutzer's reagent, 0.3633 per cent.

In order to get another point of view for these nitrogen values for the uncooked meats, the results have been calculated to percentages of the total nitrogen of the flesh taken for examination.

TABLE 118.—*Nitrogen records of the cold-water extracts of raw meats (results expressed in percentage of total nitrogen of meat taken).*

Laboratory No.	Cooking experiment No.	Kind of meat.	Total nitrogen in meat.	Total nitrogen in water extract.	Nitrogen coagulated by heat.	Nitrogen precipitated by $\text{ZnSO}_4$ (albumose).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromin in filtrate from $\text{ZnSO}_4$ precipitate.	Proteid nitrogen in water extract.
			<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1672	122	Beef, flank, raw .....	100	17.76	7.03	0.49	7.52	0.29	7.81
1668	121	Beef, neck, raw .....	100	20.22	11.03	.69	11.72	.17	11.89
1637	107	Beef, round, raw .....	100	23.29	<sup>a</sup> 1.23	<sup>a</sup> 11.81	13.04	.....	13.04
1640	108-109	.....do .....	100	24.67	<sup>a</sup> 1.68	<sup>a</sup> 10.70	12.38	.....	12.38
1647	110-113	.....do .....	100	22.21	6.63	1.82	8.45	.26	8.71
1722	131-132	.....do .....	100	23.33	11.78	.96	12.74	.....	12.74
1741	133-136	.....do .....	100	24.70	11.99	1.10	13.09	.....	13.09
1753	137-140	.....do .....	100	21.53	10.45	.71	11.16	.....	11.16
1764	141-147	.....do .....	100	24.93	12.45	.85	13.30	.....	13.30
1775	150-156	.....do .....	100	21.33	10.05	.46	10.51	.....	10.51
Average Nos. 1637, 1640, 1647, 1722, 1741, 1753, 1764, and 1775 .....			100	23.25	10.56	.98	11.83	.....	11.87
1676	123-124	Beef, rump, raw .....	100	19.00	9.30	.83	10.14	.11	10.25
Average of all beef samples .....			100	22.09	10.08	.88	11.28	<sup>b</sup> .21	11.35
1656	114-116	Veal, leg, raw .....	100	24.64	11.42	1.26	12.68	.35	13.03
1662	117-120	.....do .....	100	20.13	8.18	.74	8.92	.46	9.38
Average .....			100	22.39	9.80	1.00	10.80	.41	11.21
Average of all beef and veal samples ..			100	22.14	10.03	.90	11.21	<sup>c</sup> .28	11.33

<sup>a</sup> Not included in average.

<sup>b</sup> Average of 3 analyses.

<sup>c</sup> Average of 5 analyses.

TABLE 118.—*Nitrogen records of the cold-water extracts of raw meats (results expressed in percentage of total nitrogen of meat taken)*—Continued.

Laboratory No.	Cooking experiment No.	Kind of meat.	Non-proteid nitrogen in water extract.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by picric phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen as free ammonia.
			<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1672	122	Beef, flank, raw .....	9.95	7.67	8.53	9.23	10.16	.....	0.42
1668	121	Beef, neck, raw .....	8.33	6.87	9.77	9.61	10.34	.....	1.32
1637	107	Beef, round, raw .....	10.25	.....	.....	11.16	11.71	.....	.....
1640	108-109	.....do.....	12.29	.....	.....	13.46	12.91	.....	.....
1647	110-113	.....do.....	13.50	.....	.....	11.06	10.75	.....	.01
1722	131-132	.....do.....	10.59	.....	12.17	11.62	11.71	9.78	.....
1741	133-136	.....do.....	11.61	.....	12.48	13.16	12.93	6.92	.47
1753	137-140	.....do.....	10.37	.....	12.18	10.83	10.88	11.62	.47
1764	141-147	.....do.....	11.63	.....	13.65	12.95	12.67	14.19	.45
1775	150-156	.....do.....	10.82	.....	11.20	10.43	11.36	11.58	.42
		Average Nos. 1637, 1640, 1647, 1722, 1741, 1753, 1764, and 1775.....	11.38	.....	<i>a</i> 12.34	11.83	<i>a</i> 11.87	10.82	<i>b</i> .36
1676	123-124	Beef, rump, raw .....	8.75	7.64	9.19	9.30	9.42	.....	.51
		Average of all beef samples .....	10.74	<i>c</i> 7.39	<i>d</i> 11.15	11.16	11.35	<i>a</i> 10.82	.51
1656	114-116	Veal, leg, raw .....	11.61	10.67	11.20	12.74	12.10	.....	.39
1662	117-120	.....do.....	10.75	6.99	7.28	8.97	7.84	.....	.61
		Average .....	11.18	8.83	9.24	10.86	9.97	.....	.50
		Average of all beef and veal samples ..	10.81	<i>a</i> 7.97	<i>e</i> 10.77	11.11	11.14	<i>d</i> 10.82	.51

*a* Average of 5 analyses.*b* Average of 6 analyses.*c* Average of 3 analyses.*d* Average of 8 analyses.*e* Average of 10 analyses.

It will be observed that the soluble nitrogen found in raw meats formed 17.76 to 24.93 per cent of the total nitrogen contained in the flesh. The average amount of soluble nitrogen in terms of the total nitrogen in the 13 samples of uncooked beef and veal was 22.14 per cent. The nitrogen in the form of proteids coagulated by heat in neutral solution ranged from 6.63 per cent in a sample of beef round (No. 1647), to 12.45 per cent in another sample of this cut (No. 1764), the average for the uncooked meat being 10.03 per cent.

The average albumose nitrogen of the raw meats was 0.90 per cent. The average amount of nitrogen precipitated by bromin in the filtrate from the zinc sulphate precipitate in the 6 samples in which it was determined amounted to only 0.28 per cent of the total nitrogen. The soluble proteid nitrogen amounted to 11.33 per cent, the nonproteid nitrogen to 10.81 per cent, and the nitrogen in the form of ammonia or ammonium salts to 0.51 per cent of the total nitrogen present.

The different reagents used precipitated from cold-water extracts of raw meats the following average quantities of nitrogen: Bromin, 7.97

per cent; phosphotungstic acid in a hot solution, 10.77 per cent; phosphotungstic acid in a cold solution, 11.14 per cent; tannin and salt, 11.11 per cent, and Stutzer's reagent 10.82 per cent.

The nitrogen values for cold-water extracts of raw meat have also been calculated to the basis of total soluble nitrogen present, the results being given in Table 119.

TABLE 119.—*Nitrogen records of the cold-water extracts of raw meats (results expressed in percentage of total nitrogen of cold-water extract).*

Laboratory No.	Cooking experiment No.	Kind of meat.	Total nitrogen in meat.	Total nitrogen in water extract.	Nitrogen coagulated by heat.	Nitrogen precipitated by $\text{ZnSO}_4$ (albumose).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromin in filtrate from $\text{ZnSO}_4$ precipitate.	Proteid nitrogen in water extract.
			<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1672	122	Beef, flank, raw.....	2.479	100	39.63	2.77	42.40	1.64	44.04
1668	121	Beef, neck, raw.....	3.098	100	54.52	3.41	57.93	.83	58.76
1637	107	Beef, round, raw.....	3.390	100	a 5.27	a 50.71	55.98	.....	55.98
1640	108-109	.....do.....	3.580	100	a 6.82	a 43.38	50.20	.....	50.20
1647	110-113	.....do.....	3.350	100	29.85	8.19	38.04	1.18	39.23
1722	131-132	.....do.....	3.392	100	50.50	4.13	54.63	.....	54.63
1741	133-136	.....do.....	3.424	100	48.54	4.43	52.97	.....	52.97
1753	137-140	.....do.....	3.433	100	48.52	3.30	51.82	.....	51.82
1764	141-147	.....do.....	3.251	100	49.94	3.41	53.35	.....	53.35
1775	150-156	.....do.....	3.349	100	47.13	2.16	49.29	.....	49.29
		Average Nos. 1637, 1640, 1647, 1722, 1741, 1753, 1764, and 1775.....	3.396	100	45.75	4.27	50.79	.....	a 50.93
1676	123-124	Beef, rump, raw.....	2.400	100	48.97	4.39	53.36	.59	53.95
		Average of all beef samples.....	3.195	100	46.40	4.02	50.90	b 1.06	a 51.29
1656	114-116	Veal, leg, raw.....	3.470	100	46.36	5.11	51.47	1.40	52.87
1662	117-120	.....do.....	3.230	100	40.66	3.66	44.32	2.29	46.61
		Average.....	3.350	100	43.51	4.38	47.89	1.85	49.74
		Average of all beef and veal samples..	3.219	100	45.87	4.09	50.44	c 1.32	51.05

a Not included in average.

b Average of 3 analyses.

c Average of 5 analyses.

TABLE 119.—*Nitrogen records of the cold-water extracts of raw meats (results expressed in percentage of total nitrogen of cold-water extract—Continued).*

Laboratory No.	Cooking experiment No.	Kind of meat.	Non-proteid nitrogen in water extract.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen as free ammonia.
1672	122	Beef, flank, raw.....	<i>Per ct.</i> 55.96	<i>Per ct.</i> 43.24	<i>Per ct.</i> 48.04	<i>Per ct.</i> 51.94	<i>Per ct.</i> 57.17	.....	2.38
1668	121	Beef, neck, raw.....	41.24	33.98	48.15	47.54	51.15	.....	6.54
1637	107	Beef, round, raw.....	44.02	.....	.....	47.94	50.28	.....	.....
1640	108-109	.....do.....	49.80	.....	.....	54.54	52.33	.....	.....
1647	110-113	.....do.....	60.77	.....	.....	49.81	48.39	.....	.07
1722	131-132	.....do.....	45.37	.....	52.18	49.79	50.17	41.93	.....
1741	133-136	.....do.....	47.03	.....	50.54	53.27	52.34	28.00	1.92
1753	137-140	.....do.....	48.18	.....	56.57	50.30	50.53	53.96	2.18
1764	141-147	.....do.....	46.65	.....	54.74	51.94	50.83	56.92	1.83
1775	150-156	.....do.....	50.71	.....	52.51	48.89	53.25	54.27	1.95
		Average Nos. 1637, 1640, 1647, 1722, 1741, 1753, 1764, and 1775.....	49.07	.....	<i>a</i> 53.31	50.81	<i>a</i> 51.02	47.02	<i>b</i> 1.59
1676	123-124	Beef, rump, raw.....	46.05	40.22	48.38	48.93	49.52	.....	2.67
		Average of all beef samples.....	48.71	<i>c</i> 39.15	<i>d</i> 51.39	50.44	51.45	<i>a</i> 47.02	2.44
1656	114-116	Veal, leg, raw.....	47.13	43.33	45.48	51.68	49.03	.....	1.57
1662	117-120	.....do.....	53.39	34.71	36.14	44.55	38.97	.....	3.06
		Average.....	50.26	39.02	40.81	48.12	44.00	.....	2.32
		Average of all beef and veal samples..	48.95	<i>a</i> 39.10	<i>e</i> 49.27	50.08	50.30	<i>a</i> 47.02	2.42

*a* Average of 5 analyses.*b* Average of 6 analyses.*c* Average of 3 analyses.*d* Average of 8 analyses.*e* Average of 10 analyses.

From the foregoing table it will be seen that 29.85 to 54.52 per cent of the soluble nitrogen was present in the form of compounds coagulable by heat, the average quantity for the 13 samples of raw flesh being 45.87 per cent of the total nitrogen of soluble compounds precipitated by coagulation. By saturating the filtrate from the coagulated proteid with zinc sulphate from 2.16 to 8.19 per cent of the soluble nitrogen was precipitated as albumoses, the average amount being 4.09 per cent. The average amount of nitrogen precipitated supposedly as peptones by bromin in the filtrate from the zinc sulphate precipitate in six samples of raw meats was equal to 1.32 per cent of the total soluble nitrogen.

The nitrogen of soluble proteids formed 39.23 to 58.76 per cent of the total soluble nitrogen, averaging for the 13 samples 51.05 per cent. The nonproteid nitrogen ranged from 41.24 to 60.77 per cent of the total soluble nitrogen, the average being 48.95 per cent, and the nitrogen existing as ammonia or ammonium salts was on an average 2.42 per cent.

The other reagents used precipitated the following average quantities of nitrogen expressed in terms of total soluble nitrogen: Bromin,

39.10 per cent, phosphotungstic acid in a hot solution 49.27 per cent, phosphotungstic acid in a cold solution 50.30 per cent, tannin and salt 50.08 per cent, and Stutzer's reagent 47.02 per cent.

### FORMS OF NITROGEN IN MEATS COOKED BY BOILING.

In the following pages the data regarding the different forms of nitrogen existing in meats cooked by boiling are summarized, Table 120 showing the data calculated on the basis of the amount of meat used:

TABLE 120.—*Nitrogen records of the cold-water extracts of meats cooked by boiling (results expressed in percentage of meat taken).*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Total nitrogen in meat.	Total nitrogen in water extract.	Nitrogen coagulated by heat.	Nitrogen precipitated by $ZnSO_4$ (albumoses).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by tannin in filtrate from $ZnSO_4$ .
				At beginning.	During cooking.							
				°C.	°C.	Hrs.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1642	1640	109	Beef, round.....	Cold.	85	3	5.770	0.1598	0.0025	0.0189	0.0214	.....
1754	1753	137	.....do.....	Cold.	85	3	5.884	.2823	0	.0321	.0321	.....
			Average.....	Cold.	85	3	5.827	.2211	.0013	.0255	.0268	.....
1756	1753	139	Beef, round (browned).	Cold.	85	3	5.495	.2677	0	.0279	.0279	.....
			Average Nos. 1642, 1754, and 1756....	Cold.	85	3	5.716	.2366	.0008	.0263	.0271	.....
1746	1741	136	Beef, round (browned).	85	85	3	5.696	.2595	.0018	.0223	.0241	.....
1769	1764	145	Beef, round.....	85	85	3	5.810	.3388	.0075	.0271	.0346	.....
1780	1775	154	.....do.....	85	85	3	6.040	.2764	0	.0205	.0205	.....
			Average Nos. 1769 and 1780.....	85	85	3	5.925	.3076	.0038	.0238	.0276	.....
			Average Nos. 1746, 1769, and 1780....	85	85	3	5.849	.2916	.0031	.0233	.0264	.....
1641	1640	108	Beef, round.....	100	85	3	5.910	.1684	.0363	.0252	.0615	.....
1744	1741	134	.....do.....	100	85	3	5.862	.3066	.0064	.0458	.0522	.....
1768	1764	144	.....do.....	100	85	3	5.309	.3520	.0109	.0229	.0338	.....
1779	1775	153	.....do.....	100	85	3	6.013	.3319	0	.0320	.0320	.....
			Average.....	100	85	3	5.774	.2897	.0134	.0315	.0449	.....
1755	1753	138	Beef, round.....	Cold.	100	3	5.857	.3090	0	.0703	.0703	.....
1757	1753	140	Beef, round (browned).	Cold.	100	3	5.855	.3322	0	.0784	.0784	.....
			Average.....	Cold.	100	3	5.856	.3206	0	.0744	.0744	.....
1743	1741	133	Beef, round.....	100	100	3	5.834	.2996	.0031	.0496	.0527	.....
1745	1741	135	Beef, round (browned).	100	100	3	5.556	.2701	.0011	.0378	.0389	.....
			Average.....	100	100	3	5.695	.2849	.0021	.0437	.0458	.....
			Average of all cooked 3 hours....	.....	.....	3	5.778	.2824	.0050	.0365	.0415	.....
1646	1647	113	Beef, round.....	Cold.	65	5	5.240	.1380	.0062	.0194	.0256	0.0180
1645	1647	112	.....do.....	Cold.	85	5	5.420	.1610	.0074	.0333	.0407	.0163
1654	1656	116	Veal, leg.....	Cold.	85	5	5.070	.1892	.0117	.0771	.0888	.0064
1658	1662	118	.....do.....	Cold.	85	5	4.800	.1904	.0024	.0284	.0308	.0195
			Average Nos. 1654 and 1658.....	Cold.	85	5	4.935	.1898	.0070	.0528	.0598	.0130
			Average Nos. 1645, 1654, and 1658....	Cold.	85	5	5.097	.1802	.0071	.0463	.0534	.0141



TABLE 120.—*Nitrogen records of the cold-water extracts of meats cooked by boiling (results expressed in percentage of meat taken)*—Continued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Total nitrogen in meat.	Total nitrogen in water extract.	Nitrogen coagulated by heat.	Nitrogen precipitated by $\text{ZnSO}_4$ (albumoses).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromin in filtrate from $\text{ZnSO}_4$ .
				At beginning.	During cooking.							
				$^{\circ}\text{C}.$	$^{\circ}\text{C}.$	Hrs.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1644	1647	111	Beef, round.....	100	85	5	5.590	0.1740	0.0066	0.3308	0.0374	0.0089
1720	1722	131	.....do.....	100	85	5	5.309	.2343	.0075	.0180	.0255	
			Average.....	100	85	5	5.450	.2042	.0071	.0244	.0315	.....
1665	1668	121	Beef, neck.....	100	85	5	5.039	.1323	.0021	.0204	.0225	.0074
1673	1676	123	Beef, rump.....	100	85	5	3.245	.2117	.0098	.0420	.0518	.0091
1703	1705	125	.....do.....	100	85	5	4.433	.1536	.0131	.0476	.0607	.....
			Average Nos. 1673 and 1703.....	100	85	5	3.839	.1827	.0115	.0448	.0563	.....
1669	1672	122	Beef, flank.....	100	85	5	3.210	.0769	.0132	.0466	.0598	.0032
1653	1656	115	Veal, leg.....	100	85	5	5.360	.3012	.0169	.0495	.0664	.0128
1664	1662	117	.....do.....	100	85	5	4.900	.2270	.0071	.0353	.0424	.0091
			Average Nos. 1653 and 1664.....	100	85	5	5.130	.2641	.0120	.0424	.0544	.0110
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	100	85	5	4.636	.1889	.0096	.0363	.0459	.0084
1639	1637	107	Beef, round.....	100	100	5	5.640	.3087	.0387	.1160	.1547	.....
1643	1647	110	.....do.....	100	100	5	5.370	.2880	.0230	.1106	.1336	.0133
1721	1722	132	.....do.....	100	100	5	5.324	.2974	.0104	.0789	.0893	.....
			Average.....	100	100	5	5.445	.2980	.0240	.1018	.1258	.....
1704	1705	126	Beef, rump.....	100	100	5	4.583	.3145	.0124	.1316	.1440	.....
1652	1656	114	Veal, leg.....	100	100	5	5.310	.4284	.0138	.0388	.0526	.0177
			Average Nos. 1639, 1643, 1652, 1704, and 1721.....	100	100	5	5.246	.3274	.0196	.0952	.1148	<i>a</i> .0155
			Average of all cooked 5 hours.....	.....	.....	5	4.933	.2251	.0119	.0544	.0663	<i>b</i> .0118
			Average of all cooked 3 or 5 hours.....	.....	.....	.....	5.318	.2510	.0088	.0463	.0551	<i>b</i> 1.018

*a* Average of 2 analyses.*b* Average of 12 analyses.

TABLE 120.—*Nitrogen records of the cold-water extracts of meats cooked by boiling (results expressed in percentage of meat taken)*—Continued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Proteid nitrogen in water extract.	Nonproteid nitrogen in water extract.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen precipitated by alcohol.	Nitrogen as free ammonia.
1642	1640	109	Beef, round.....	<i>P. ct.</i> 0.0214	<i>P. ct.</i> 0.1384	<i>P. ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
1754	1753	137	.....do.....	.0321	.2502	.....	0.1564	.0420	.0458	0.0882	.....	0.0174
			Average.....	.0268	.1943	.....	.....	.0230	.0280	.....	.....	.....
1756	1753	139	Beef, round (browned).....	.0279	.2398	.....	.0116	.0340	.0593	.0832	.....	.0159
			Average Nos. 1642, 1754, and 1756.....	.0271	.2095	.....	a. 0.0840	.0266	.0384	a. 0.0857	.....	a. 0.0167
1746	1741	136	Beef, round (browned).....	.0241	.2354	.....	.0083	.0308	.0494	.0291	.....	.0130
1769	1764	145	Beef, round.....	.0346	.3042	.....	.0272	.0325	.0345	.0637	.....	.0221
1780	1775	154	.....do.....	.0205	.2559	.....	.0199	.0156	.0225	.0692	.....	.0210
			Average Nos. 1769 and 1780.....	.0276	.2800	.....	.0236	.0241	.0285	.0815	.....	.0216
			Average Nos. 1746, 1769, and 1780.....	.0264	.2652	.....	.0185	.0263	.0355	.0640	.....	.0187
1641	1640	108	Beef, round.....	.0615	.1069	.....	.....	.0223	.0325	.....	.....	.....
1744	1741	134	.....do.....	.0522	.2544	.....	.0478	.0560	.0568	.0576	.....	.0174
1768	1764	144	.....do.....	.0338	.3182	.....	.0346	.0172	.0438	.0876	.....	.0246
1779	1775	153	.....do.....	.0320	.2999	.....	.0334	.0297	.1313	.0913	.....	.0164
			Average.....	.0449	.2448	.....	b. 0.0386	.0313	.0661	.0788	.....	.0195
1755	1753	138	Beef, round.....	.0703	.2387	.....	.0700	.0801	.0898	.1193	.....	.0230
1757	1753	140	Beef, round (browned).....	.0784	.2538	.....	.0848	.0888	.0917	.1349	.....	.0234
			•Average.....	.0744	.2462	.....	.0774	.0845	.0908	.1271	.....	.0232
1743	1741	133	Beef, round.....	.0527	.2469	.....	.0199	.0565	.0679	.0492	.....	.0192
1745	1741	135	Beef, round (browned).....	.0389	.2312	.....	.0088	.0368	.0568	.0485	.....	.0207
			Average.....	.0458	.2390	.....	.0144	.0467	.0624	.0489	.....	.0200
			Average of all cooked 3 hours.....	.0415	.2410	.....	.....	.0390	.0566	c. 0.0793	.....	c. 0.0195
1646	1647	113	Beef, round.....	.0436	.0944	.....	.....	.0313	.0202	.....	.....	.0002
1645	1647	112	.....do.....	.0570	.1040	.....	.....	.0325	.0356	.....	.....	.0001
1654	1656	116	Veal, leg.....	.0952	.0940	0.0131	.0062	.....	.0003	.....	.....	.....
1658	1662	118	.....do.....	.0503	.1401	.0275	.0210	.0482	.0595	.....	.....	.0049
			Average Nos. 1654 and 1658.....	.0728	.1171	.0203	.0136	.....	.0299	.....	.....	.....
			Average Nos. 1645, 1654, and 1658.....	.0675	.1127	.....	.....	.0404	.0318	.....	.....	.0025
1644	1647	111	Beef, round.....	.0463	.1277	.....	.....	.0183	.0240	.....	.....	.0003
1720	1722	131	.....do.....	.0255	.2088	.....	.0299	.1048	.1209	.1382	0.0401	.0078
			Average.....	.0359	.1683	.....	.....	.0616	.0725	.....	.....	.0041
1665	1668	121	Beef, neck.....	.0299	.1024	.0062	.0108	.0322	.0305	.....	.....	.0119
1673	1676	123	Beef, rump.....	.0609	.1508	.0103	.0280	.0708	.1018	.....	.....	.0180
1703	1705	125	.....do.....	.0607	.0929	.....	.0240	.0417	.0491	.0611	.0468	.0148
			Average Nos. 1673 and 1703.....	.0608	.1219	.....	.0260	.0563	.0755	.....	.....	.0164

a Average of 2 analyses.

b Average of 3 analyses.

c Average of 12 analyses.

TABLE 120.—*Nitrogen records of the cold-water extracts of meats cooked by boiling (results expressed in percentage of meat taken)*—Continued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Proteid nitrogen in water extract.	Nonproteid nitrogen in water extract.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen precipitated by alcohol.	Nitrogen as free ammonia.
				<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
1669	1672	122	Beef, flank.....	0.0630	0.0139	0.0062	0.0258	0.0142	0.0487	.....	.....	.....
1653	1656	115	Veal, leg.....	.0792	.2220	.0263	.0083	.0456	.0613	.....	.....	0.0040
1664	1662	117	.....do.....	.0515	.1755	.0295	.0258	.0452	.0332	.....	.....	.0214
			Average Nos. 1653 and 1664.....	.0654	.1988	.0279	.0171	.0454	.0473	.....	.....	.0127
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	.0521	.1368	<i>a</i> .0157	<i>b</i> .0218	.0466	.0587	.....	.....	.0098
1639	1637	107	Beef, round.....	.1547	.1540	.....	.....	.1050	.1278	.....	.....	.....
1643	1647	110	.....do.....	.1469	.1411	.....	.....	.1061	.1091	.....	.....	.0006
1721	1722	132	.....do.....	.0893	.2081	.....	.1005	.0580	.1063	0.0972	0.0119	.0180
			Average.....	.1303	.1677	.....	.....	.0897	.1144	.....	.....	.0093
1761	1705	126	Beef, rump.....	.1440	.1705	.....	.1151	.1379	.1476	.1211	.1426	.0172
1652	1656	114	Veal, leg.....	.0703	.3581	.0737	.0630	.0775	.1001	.....	.....	.....
			Average Nos. 1639, 1643, 1652, 1704, and 1721.....	.1210	.2064	.....	.0929	.0969	.1182	.1092	.0773	.0119
			Average of all cooked 5 hours ...	.0746	.1503	.0241	.0382	.0606	.0692	.1054	.0604	.0085
			Average of all cooked 3 or 5 hours .....	.0597	.1913	<i>c</i> .0241	<i>d</i> .0409	.0505	.0635	<i>e</i> .0858	.0604	.0136

*a* Average of 5 analyses.*b* Average of 7 analyses.*c* Average of 8 analyses.*d* Average of 23 analyses.*e* Average of 16 analyses.

It will be seen that the total nitrogen in the boiled beef and veal ranged from 3.210 per cent in a sample of beef flank (No. 1669) to 6.040 per cent in a sample of beef round (No. 1780), the average for 31 samples of meats cooked in hot water being 5.318 per cent.

The total nitrogen of compounds soluble in cold water formed 0.0769 to 0.4284 per cent of the weight of the meats, the average being 0.2510 per cent.

The nitrogen in the form of proteids coagulated by heat in neutral solution varied from nothing in a considerable number of samples to 0.0387 per cent in a sample of beef round (No. 1639), the average being 0.0088 per cent. As will be seen by reference to Table 117, the amounts of coagulable proteid in cold-water extracts of raw flesh was 36.5 times as great as that in meats cooked in hot water.

The average amount of albumose nitrogen in the 31 samples of boiled meats, as determined by precipitation with zinc sulphate, was 0.0463 per cent, the average amount in the 13 samples of raw meats being 0.0290 per cent. These figures seem to point to the conclusion that during the process of cooking meats in hot water the proteids

undergo hydration to a certain extent. This conclusion is confirmed when the amount of albumoses in the meats cooked for three hours in hot water is compared with those cooked for five hours. Notwithstanding the fact that the average total nitrogen in the samples cooked for five hours was decidedly less than in those cooked for three hours, the former contained 0.0544 per cent of albumoses and the latter only 0.0365 per cent—that is to say, the longer the time of cooking the greater the quantity of albumoses found in the resulting cooked meat. Further confirmation is found in the fact that the amounts of nitrogen found in the meats cooked mainly at 85° C. was 0.0329 per cent, while in those cooked mainly at 100° C. it was 0.0791 per cent.

In the twelve samples of boiled meats in which the nitrogen in the form of peptones was determined by the bromin method the average amount was 0.0118 per cent.

The nitrogen soluble proteids ranged from 0.0205 per cent in a sample of beef round (No. 1780) to 0.1547 per cent in another sample (No. 1639) of the same cut, the average for the 31 samples being 0.0597 per cent. The average for the corresponding form of nitrogen in meats cooked for five hours was 0.0746 per cent, in those cooked for three hours 0.0415 per cent, and in the 13 samples of raw meats 0.3682 per cent.

While in raw meats the soluble nitrogen was about equally divided between proteid and nonproteid substances, this is certainly not the case with boiled meats, as it will be seen that the nonproteid nitrogen varies from 0.3681 to 0.9139 per cent, the average for 31 samples being 0.1913 per cent. While meats which have been cooked for five hours contain much more soluble proteid than do meats which have been cooked for three hours, the latter contain considerably more nonproteid nitrogen than the former. The average nonproteid nitrogen in 14 samples of meats which had been cooked for three hours was 0.2410 per cent, and in 17 samples cooked for five hours it was only 0.1505 per cent.

The analyses show that there is a small amount of nitrogen present as ammonia or ammonium salts in the cold-water extracts of boiled meats. The average of 26 determinations showed 0.0136 per cent nitrogen in this condition.

The average quantities of nitrogen precipitated by various reagents from cold-water extracts of boiled meats were: Bromin, 0.0241 per cent; phosphotungstic acid in a hot solution, 0.0409 per cent; phosphotungstic acid in a cold solution, 0.0635 per cent; tannin and salt, 0.0505 per cent, and Stutzer's reagent, 0.0858 per cent.

In Table 121, which follows, the nitrogen records of the meats cooked by boiling are calculated in the percentages of the total nitrogen contained in the cooked flesh.

TABLE 121.—*Nitrogen records of the cold-water extracts of meats cooked by boiling (results expressed in percentage of the total nitrogen of meat taken).*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Total nitrogen in meat.	Total nitrogen in water extract.	Nitrogen coagulated by heat.	Nitrogen precipitated by ZnSO <sub>4</sub> (albumose.)	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromin in filtrate from ZnSO <sub>4</sub> .
				At beginning.	During cooking.							
				°C.	°C.	Hrs.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
1642	1640	109	Beef, round .....	Cold.	85	3	100	2.77	0.04	0.33	0.37	.....
1754	1753	137	do .....	Cold.	85	3	100	4.80	0	.55	.55	.....
			Average .....	Cold.	85	3	100	3.78	.02	.44	.46	.....
1756	1753	139	Beef, round (browned)	Cold.	85	3	100	4.87	0	.51	.51	.....
			Average Nos. 1642, 1754, and 1756....	Cold.	85	3	100	4.15	.01	.46	.47	.....
1746	1741	136	Beef, round (browned)	85	85	3	100	4.56	.03	.39	.42	.....
1769	1764	145	Beef, round .....	85	85	3	100	5.83	.13	.47	.60	.....
1780	1775	154	do .....	85	85	3	100	4.58	0	.34	.34	.....
			Average Nos. 1769 and 1780.....	85	85	3	100	5.21	.07	.40	.47	.....
			Average Nos. 1746, 1769, and 1780....	85	85	3	100	4.99	.05	.40	.45	.....
1641	1640	108	Beef, round .....	100	85	3	100	2.85	.61	.43	1.04	.....
1744	1741	134	do .....	100	85	3	100	5.23	.11	.78	.89	.....
1768	1764	144	do .....	100	85	3	100	6.63	.21	.43	.64	.....
1779	1775	153	do .....	100	85	3	100	5.52	0	.53	.53	.....
			Average .....	100	85	3	100	5.06	.23	.54	.77	.....
1755	1753	138	Beef, round .....	Cold.	100	3	100	5.28	0	1.20	1.20	.....
1757	1753	140	Beef, round (browned)	Cold.	100	3	100	5.67	0	1.34	1.34	.....
			Average .....	Cold.	100	3	100	5.48	0	1.27	1.27	.....
1743	1741	133	Beef, round .....	100	100	3	100	5.13	.05	.85	.90	.....
1745	1741	135	Beef, round (browned)	100	100	3	100	4.86	.02	.68	.70	.....
			Average .....	100	100	3	100	5.00	.04	.76	.80	.....
			Average of all cooked 3 hours....				100	4.90	.08	.63	.71	.....
1646	1647	113	Beef, round .....	Cold.	65	5	100	2.63	.12	.37	.49	0.34
1645	1647	112	do .....	Cold.	85	5	100	2.97	.14	.61	.75	.30
1654	1656	116	Veal, leg .....	Cold.	85	5	100	3.73	.23	1.52	1.75	.13
1658	1662	118	do .....	Cold.	85	5	100	3.97	.05	.59	.64	.41
			Average Nos. 1654 and 1658....	Cold.	85	5	100	3.85	.14	1.06	1.20	.27
			Average Nos. 1645, 1654, and 1658....	Cold.	85	5	100	3.56	.14	.91	1.05	.28
1644	1647	111	Beef, round .....	100	85	5	100	3.11	.12	.55	.67	.16
1720	1722	131	do .....	100	85	5	100	4.41	.14	.34	.48	.....
			Average .....	100	85	5	100	3.76	.13	.45	.58	.....
1665	1668	121	Beef, neck .....	100	85	5	100	2.62	.04	.40	.44	.15
1673	1676	123	Beef, rump .....	100	85	5	100	6.52	.30	1.29	1.59	.28
1703	1705	125	do .....	100	85	5	100	3.47	.30	1.07	1.37	.....
			Average Nos. 1673 and 1703.....	100	85	5	100	5.00	.30	1.18	1.48	.....



TABLE 121.—*Nitrogen records of the cold-water extracts of meats cooked by boiling (results expressed in percentage of the total nitrogen of meat taken)*—Continued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Total nitrogen in meat.	Total nitrogen in water extract.	Nitrogen coagulated by heat.	Nitrogen precipitated by $\text{ZnSO}_4$ (albumose).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromin in filtrate from $\text{ZnSO}_4$ .
				At beginning.	During cooking.							
				$^{\circ}\text{C}$ .	$^{\circ}\text{C}$ .	Hrs.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
1669	1672	122	Beef, flank.....	100	85	5	100	2.40	0.41	1.45	1.86	0.10
1653	1656	115	Veal, leg.....	100	85	5	100	5.62	.32	.92	1.24	.24
1664	1662	117	.....do.....	100	85	5	100	4.63	.14	.72	.86	.19
			Average Nos. 1653 and 1664.....	100	85	5	100	5.13	.23	.82	1.05	.22
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....				100	4.10	.22	.84	1.06	.19
1639	1637	107	Beef, round.....	100	100	5	100	5.47	.69	2.06	2.75	.....
1643	1647	110	.....do.....	100	100	5	100	5.36	.43	2.06	2.49	.25
1721	1722	132	.....do.....	100	100	5	100	5.59	.20	1.48	1.68	.....
			Average.....	100	100	5	100	5.47	.44	1.87	2.31	.....
1704	1705	126	Beef, rump.....	100	100	5	100	6.86	.27	2.87	3.14	.....
1652	1656	114	Veal, leg.....	100	100	5	100	8.07	.26	.73	.99	.33
			Average Nos. 1639, 1643, 1652, 1704, and 1721.....	100	100	5	100	6.27	.37	1.84	2.21	.29
			Average of all cooked 5 hours.....			5	100	4.56	.24	1.12	1.36	.24
			Average of all cooked 3 and 5 hours.....				100	4.71	.17	.90	1.07	.24

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Proteid nitrogen in water extract.		Nonproteid nitrogen in water extract.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen precipitated by alcohol.	Nitrogen as free ammonia.
				P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
1642	1640	109	Beef, round.....	0.37	2.40	.....	.....	0.07	0.18	.....	.....	.....	.....
1754	1753	137	.....do.....	.55	4.25	.....	2.66	.72	.78	1.50	.....	.....	0.29
			Average.....	.46	3.33	.....	.....	.40	.48	.....	.....	.....	.....
1756	1753	139	Beef, round (browned)	.51	4.36	.....	.21	.62	1.08	1.51	.....	.....	.29
			Average Nos. 1642, 1754, and 1756.....	.47	3.68	.....	.....	.47	.68	.....	.....	.....	.....
1746	1741	136	Beef, round (browned)	.42	4.14	.....	.15	.54	.87	.51	.....	.....	.23
1769	1764	145	Beef, round.....	.60	5.23	.....	.47	.56	.59	1.61	.....	.....	.38
1780	1775	154	.....do.....	.34	4.24	.....	.33	.26	.38	1.15	.....	.....	.35
			Average Nos. 1769 and 1780.....	.47	4.74	.....	.40	.41	.49	1.38	.....	.....	.37
			Average Nos. 1746, 1769, and 1780.....	.45	4.54	.....	.32	.45	.61	1.09	.....	.....	.32
1641	1640	108	Beef, round.....	1.04	1.81	.....	.....	.38	.55	.....	.....	.....	.....
1744	1741	134	.....do.....	.89	4.34	.....	.82	.96	.97	.98	.....	.....	.30
1768	1764	144	.....do.....	.64	5.99	.....	.65	.32	.82	1.65	.....	.....	.46
1779	1775	153	.....do.....	.53	4.99	.....	.56	.49	2.18	1.52	.....	.....	.27
			Average.....	.77	4.29	.....	a. 68	.54	1.13	1.38	.....	.....	.34

a Average of 3 analyses.

TABLE 121.—*Nitrogen records of the cold-water extracts of meats cooked by boiling (results expressed in percentage of the total nitrogen of meat taken)*—Continued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat	Proteid nitrogen in water extract.	Nonproteid nitrogen in water extract.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen precipitated by alcohol.	Nitrogen as free ammonia.
1755	1753	138	Beef, round.....	<i>P. ct.</i> 1.20	<i>P. ct.</i> 4.08	<i>P. ct.</i> .....	<i>Per ct.</i> 0.12	<i>Per ct.</i> 1.37	<i>Per ct.</i> 1.54	<i>Per ct.</i> 2.04	<i>P. ct.</i> .....	<i>P. ct.</i> 0.39
1757	1753	140	Beef, round (browned)	1.34	4.33	.....	1.45	1.51	1.56	2.30	.....	.40
			Average.....	1.27	4.21	.....	.79	1.44	1.55	2.17	.....	.40
1743	1741	133	Beef, round.....	.90	4.23	.....	.34	.96	1.16	.84	.....	.33
1745	1741	135	Beef, round (browned)	.70	4.16	.....	.16	.66	1.01	.87	.....	.39
			Average.....	.80	4.20	.....	.25	.81	1.09	.86	.....	.36
			Average of all cooked 3 hours...	.71	4.19	.....	.66	.67	.98	<i>a</i> 1.37	.....	<i>b</i> .34
1646	1647	113	Beef, round.....	.83	1.80	.....	.....	.59	.38	.....	.....	Trace
1645	1647	112	do.....	1.05	1.92	.....	.....	.60	.66	.....	.....	Trace
1654	1656	116	Veal, leg.....	1.88	1.85	0.26	.12	.....	.....	.....	.....	.....
1658	1662	118	do.....	1.05	2.92	.57	.44	1.01	1.24	.....	.....	.10
			Average Nos. 1654 and 1658.....	1.47	2.39	.42	.28	.....	.....	.....	.....	.....
			Average Nos. 1645, 1654 and 1658.....	1.33	2.23	.42	.28	.81	.95	.....	.....	.05
1644	1647	111	Beef, round.....	.83	2.28	.....	.....	.32	.42	.....	.....	.01
1720	1722	131	do.....	.48	3.93	.....	.56	1.97	2.27	2.60	0.76	.15
			Average.....	.66	3.11	.....	.....	1.15	1.35	.....	.....	.08
1665	1668	121	Beef, neck.....	.59	2.03	.87	.69	.62	.60	.....	.....	.24
1673	1676	123	Beef, rump.....	1.87	4.65	.32	.86	2.18	3.13	.....	.....	.55
1703	1705	125	do.....	1.37	2.10	.....	.54	.94	1.11	1.38	1.06	.34
			Average Nos. 1673 and 1703.....	1.62	3.38	.....	.70	1.56	2.12	.....	.....	.45
1669	1672	122	Beef, flank.....	1.96	.44	.19	.80	.45	.88	.....	.....	0
1653	1656	115	Veal, leg.....	1.48	4.14	.49	.16	.85	1.14	.....	.....	.07
1664	1662	117	do.....	1.05	3.58	.60	.53	.92	.67	.....	.....	.44
			Average Nos. 1653 and 1664.....	1.27	3.86	.55	.35	.89	.91	.....	.....	.26
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	1.21	2.89	<i>b</i> .49	<i>c</i> .59	1.03	1.28	1.99	.91	.24
1639	1637	107	Beef, round.....	2.75	2.72	.....	.....	1.86	2.27	.....	.....	.....
1643	1647	110	do.....	2.74	2.62	.....	.....	1.97	2.03	.....	.....	.01
1721	1722	132	do.....	1.68	3.91	.....	1.89	1.09	2.00	1.83	.22	.34
			Average.....	2.39	3.08	.....	.....	1.64	2.10	.....	.....	.18
1704	1705	126	Beef, rump.....	3.14	3.72	.....	2.51	3.01	3.22	2.64	3.11	.38
1652	1656	114	Veal, leg.....	1.32	6.75	1.39	1.19	1.46	1.89	.....	.....	.....
			Average Nos. 1639, 1643, 1652, 1704, and 1721.....	2.33	3.94	.....	1.86	1.88	2.28	2.24	1.67	.24
			Average of all cooked 5 hours...	1.54	3.02	.59	.86	1.24	1.49	2.11	1.29	.19
			Average of all cooked 3 and 5 hours.....	1.17	3.55	.59	.76	.97	1.26	1.56	1.29	.26

*a* Average of 12 analyses.*b* Average of 5 analyses.*c* Average of 7 analyses.

It will be noted that the soluble nitrogen in the boiled meats ranged from 2.40 to 8.07 per cent of the total nitrogen contained in the cooked product, the average for the 31 samples being 4.73 per cent.

The average quantity of nitrogen of soluble compounds coagulated by heat in neutral solution was 0.17 per cent, and the average albumose nitrogen in the cold-water extracts was 0.90 per cent, which is the same as the corresponding figure for raw meats. In the 12 samples where nitrogen was precipitated by bromin from the zinc sulphate filtrate the amount found was only 0.24 per cent.

The average amount of soluble proteid nitrogen in the 31 samples was 1.17 per cent of the total nitrogen present, and the nonproteid 3.55 per cent. By reference to Table 118 it will be seen that in raw meats the proteid nitrogen is ten times greater than in cold-water extracts of boiled meats. The nitrogen in the form of ammonia or ammonium compounds made up 0.26 per cent of the total nitrogen present in the boiled meats.

The other reagents used in estimating the nitrogenous compounds in the cold-water extracts of boiled meats separated the following average amounts: Bromin, 0.59 per cent; phosphotungstic acid in a hot solution, 0.76 per cent; phosphotungstic acid in a cold solution, 1.26 per cent; tannin and salt, 0.97 per cent, and Stutzer's reagent, 1.56 per cent. For corresponding results obtained from the raw meats, see page 147.

In Table 122 the figures for the nitrogen of the boiled meats are given in percentages of the total soluble nitrogen.

TABLE 122.—*Nitrogen records of the cold water extracts of meats cooked by boiling (results expressed in percentage of the total nitrogen of the water extract).*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Total nitrogen in meat.	Total nitrogen in water extract.	Nitrogen coagulated by heat.	Nitrogen precipitated by ZnSO <sub>4</sub> (albumose).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromin in filtrate from ZnSO <sub>4</sub> .
				At beginning.	During cooking.							
				°C.	°C.	Hrs.	P. ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1642	1640	109	Beef, round.....	Cold.	85	3	5.77	100	1.56	11.83	13.39	.....
1754	1753	137	.....do.....	Cold.	85	3	5.88	100	0	11.37	11.37	.....
			Average .....	Cold.	85	3	5.83	100	.78	11.60	12.38	.....
1756	1753	139	Beef, round (browned)	Cold.	85	3	5.50	100	0	10.42	10.42	.....
			Average Nos. 1642, 1754, and 1756....	Cold.	85	3	5.72	100	.52	11.21	11.73	.....
1746	1741	136	Beef, round (browned)	85	85	3	5.70	100	.69	8.60	9.29	.....
1769	1764	145	Beef, round.....	85	85	3	5.81	100	2.21	8.00	10.21	.....
1780	1775	154	.....do.....	85	85	3	6.04	100	0	7.42	7.42	.....
			Average Nos. 1769 and 1780.....	85	85	3	5.93	100	1.11	7.71	8.82	.....
			Average Nos. 1746, 1769, and 1780 ....	.....	.....	.....	5.85	100	.97	8.01	8.97	.....

TABLE 122.—*Nitrogen records of the cold-water extracts of meats cooked by boiling (results expressed in percentage of the total nitrogen of the water extract)*—Cont inued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Total nitrogen in meat.	Total nitrogen in water extract.	Nitrogen coagulated by heat.	Nitrogen precipitated by ZnSO <sub>4</sub> (albumoses).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromin in filtrate from ZnSO <sub>4</sub> .
				At beginning.	During cooking.							
				°C.	°C.	Hrs.	P. ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1641	1640	108	Beef, round.....	100	85	3	5.91	100	21.55	14.96	36.51	.....
1744	1741	134	.....do.....	100	85	3	5.86	100	2.09	14.94	17.03	.....
1768	1764	144	.....do.....	100	85	3	5.31	100	3.10	6.50	9.60	.....
1779	1775	133	.....do.....	100	85	3	6.01	100	0	9.64	9.64	.....
			Average.....	100	85	3	5.77	100	6.69	11.51	18.20	.....
1755	1753	138	Beef, round.....	Cold.	100	3	5.86	100	0	22.75	22.75	.....
1757	1753	140	Beef, round (browned)	Cold.	100	3	5.86	100	0	23.60	23.60	.....
			Average.....	Cold.	100	3	5.86	100	0	23.18	23.18	.....
1743	1741	133	Beef, round.....	100	100	3	5.83	100	1.04	16.56	17.60	.....
1745	1741	135	Beef, round (browned)	100	100	3	5.56	100	.41	13.99	14.40	.....
			Average.....	100	100	3	5.70	100	.73	15.28	16.01	.....
			Average of all cooked 3 hours.....			3	5.78	100	2.34	12.90	15.24	.....
1646	1647	113	Beef, round.....	Cold.	65	5	5.24	100	4.49	14.06	18.55	13.04
1645	1647	112	.....do.....	Cold.	85	5	5.24	100	4.60	20.68	25.28	10.12
1654	1656	116	Veal, leg.....	Cold.	85	5	5.070	100	6.18	40.75	46.93	3.38
1658	1662	118	.....do.....	Cold.	85	5	4.800	100	1.26	14.92	16.18	10.24
			Average Nos. 1654 and 1658.....	Cold.	85	5	4.935	100	3.72	27.84	31.56	6.81
			Average Nos. 1645, 1654, and 1658.....	Cold.	85	5	5.037	100	4.01	25.45	29.46	7.91
1644	1647	111	Beef, round.....	100	85	5	5.590	100	3.79	17.70	21.49	5.11
1720	1722	131	.....do.....	100	85	5	5.309	100	3.20	7.68	10.88	.....
			Average.....	100	85	5	5.450	100	3.50	12.69	16.19	.....
1665	1668	121	Beef, neck.....	100	85	5	5.039	100	1.58	15.42	17.00	5.60
1673	1676	123	Beef, rump.....	100	85	5	3.245	100	4.63	19.84	24.47	4.30
1703	1705	125	.....do.....	100	85	5	4.433	100	8.53	30.99	39.52	.....
			Average Nos. 1673 and 1703.....	100	85	5	3.839	100	6.58	25.42	32.00	.....
1669	1672	122	Beef, flank.....	100	85	5	3.210	100	17.17	60.60	77.77	4.16
1653	1656	115	Veal, leg.....	100	85	5	5.360	100	5.61	16.43	22.04	4.25
1664	1662	117	.....do.....	100	85	5	4.900	100	3.13	15.55	18.68	4.01
			Average Nos. 1653 and 1664.....	100	85	5	5.130	100	4.37	15.99	20.36	4.13
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	100	85	5	4.636	100	5.96	23.03	28.98	4.57
1639	1637	107	Beef, round.....	100	100	5	5.640	100	12.54	37.57	50.11	.....
1643	1647	110	.....do.....	100	100	5	5.370	100	7.99	38.40	46.39	4.62
1721	1722	132	.....do.....	100	100	5	5.324	100	3.50	26.53	30.03	.....
			Average.....	100	100	5	5.445	100	8.01	34.17	42.18	.....
1704	1705	126	Beef, rump.....	100	100	5	4.583	100	3.94	41.85	45.79	.....
1652	1656	114	Veal, leg.....	100	100	5	5.310	100	3.22	9.06	12.28	4.13
			Average Nos. 1639, 1643, 1652, 1704, and 1721.....	100	100	5	5.245	100	6.24	30.68	36.92	4.38
			Average of all cooked 5 hours.....				4.921	100	5.61	25.18	30.79	6.08
			Average of all cooked for 3 and 5 hours.....				5.315	100	4.13	19.63	23.76	6.08



TABLE 122.—*Nitrogen records of the cold-water extracts of meat cooked by boiling (results expressed in percentage of the total nitrogen of the water extract)*—Continued.

Laboratory No.	Raw meat used N <sup>a</sup>	Cooking experiment No.	Kind of meat.	Proteid nitrogen in water extract.	Nonproteid nitrogen in water extract.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen precipitated by alcohol.	Nitrogen as free ammonia.
				<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
1642 1754	1640 1753	109 137	Beef, round.....	13.39	86.61	.....	.....	2.44	6.38	.....	.....	.....
			.....do.....	11.37	88.63	.....	55.40	14.88	16.23	31.24	.....	6.16
			Average.....	12.38	87.62	.....	.....	8.66	11.31	.....	.....	.....
1756	1753	139	Beef, round (browned)	10.42	89.58	.....	4.33	12.70	22.15	31.08	.....	5.94
			Average Nos. 1642, 1754, and 1756.....	11.73	88.27	.....	29.87	10.01	14.92	31.16	.....	6.05
1746 1769 1780	1741 1764 1775	136 145 154	Beef, round (browned)	9.29	90.71	.....	3.20	11.87	19.04	11.21	.....	5.01
			Beef, round.....	10.21	89.79	.....	8.03	9.59	10.18	27.66	.....	6.52
			.....do.....	7.42	92.58	.....	7.20	5.64	8.14	25.04	.....	7.60
			Average Nos. 1769 and 1780.....	8.82	91.18	.....	7.62	7.62	9.16	26.35	.....	7.06
			Average Nos. 1746, 1769, and 1780.....	8.98	91.02	.....	6.14	9.03	12.45	21.30	.....	6.38
1641 1744 1768 1779	1640 1741 1764 1775	108 134 144 153	Beef, round.....	36.51	63.49	.....	.....	13.24	19.30	.....	.....	.....
			.....do.....	17.03	82.97	.....	15.59	18.27	18.53	18.79	.....	5.68
			.....do.....	9.60	90.40	.....	9.83	4.89	12.14	24.89	.....	7.00
			.....do.....	9.64	90.36	.....	10.07	8.95	39.56	27.51	.....	4.94
			Average.....	18.20	81.80	.....	11.83	11.34	22.46	23.73	.....	5.87
1755 1757	1753 1753	138 140	Beef, round.....	22.75	77.25	.....	22.65	25.92	29.06	38.61	.....	7.44
			Beef, round (browned)	23.60	76.40	.....	25.53	26.73	27.60	40.61	.....	7.04
			Average.....	23.18	76.83	.....	24.09	26.33	28.33	39.61	.....	7.24
1743 1745	1741 1741	133 135	Beef, round.....	17.60	82.40	.....	6.64	18.86	22.66	16.42	.....	6.41
			Beef, round (browned)	14.40	85.60	.....	3.26	13.62	20.73	17.96	.....	7.67
			Average.....	16.00	84.00	.....	4.95	16.24	21.70	17.19	.....	7.04
			Average of all cooked 3 hours.....	15.24	84.76	.....	14.31	13.40	19.43	25.92	.....	6.45
1646 1645	1647 1647	113 112	Beef, round.....	31.59	68.41	.....	.....	22.68	14.63	.....	.....	14
			.....do.....	35.40	64.60	.....	.....	20.19	22.11	.....	.....	06
1654 1658	1656 1662	116 118	Veal, leg.....	50.31	49.69	6.93	3.28	.....	16	.....	.....	.....
			.....do.....	26.42	73.58	14.44	11.03	25.32	31.25	.....	.....	2.57
			Average Nos. 1654 and 1658.....	38.37	61.64	10.69	7.16	.....	15.71	.....	.....	.....
			Average Nos. 1645, 1654, and 1658.....	37.38	62.62	.....	.....	22.76	17.84	.....	.....	1.32
1644 1720	1647 1722	111 131	Beef, round.....	26.60	73.40	.....	.....	10.52	13.79	.....	.....	17
			.....do.....	10.88	89.12	.....	12.76	44.73	51.60	58.98	17.11	3.33
			Average.....	18.74	81.26	.....	.....	27.63	32.70	.....	.....	1.75
1665 1673 1703	1668 1676 1705	121 123 125	Beef, neck.....	22.60	77.40	3.32	2.65	24.34	23.05	.....	.....	8.99
			Beef, rump.....	28.77	71.23	4.86	13.23	33.44	48.09	.....	.....	8.50
			.....do.....	39.52	60.48	.....	15.63	27.15	31.97	39.78	30.47	9.64
			Average Nos. 1673 and 1703.....	34.15	65.86	.....	14.43	30.30	40.03	.....	.....	9.07

<sup>a</sup> Average of 3 analyses.<sup>b</sup> Average of 12 analyses.



TABLE 122.—*Nitrogen records of the cold-water extracts of meats cooked by boiling (results expressed in percentage of the total nitrogen of the water extract)*—Continued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Proteid nitrogen in water extract.	Nonproteid nitrogen in water extract.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen precipitated by alcohol.	Nitrogen as free ammonia.
				<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
1669	1672	122	Beef, flank .....	81.93	18.07	8.06	33.55	18.47	36.67	.....	.....	0
1653	1656	115	Veal, leg. ....	26.29	73.71	8.73	2.76	15.14	20.35	.....	.....	1.32
1664	1662	117	do. ....	22.69	77.31	13.00	11.37	19.91	14.63	.....	.....	9.43
			Average Nos. 1653 and 1664. ....	24.49	75.51	10.87	7.07	17.53	17.49	.....	.....	5.38
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720. ....	32.41	67.59	7.59	13.14	24.21	30.02	49.38	23.79	5.17
1639	1637	107	Beef, round .....	50.11	49.89	.....	.....	34.01	41.40	.....	.....	.....
1643	1647	110	do. ....	51.01	48.99	.....	.....	36.84	37.88	.....	.....	.....
1721	1722	132	do. ....	30.03	69.97	.....	33.80	19.50	35.74	32.68	4.00	6.05
			Average. ....	43.72	56.28	.....	.....	30.12	38.34	.....	.....	3.13
1701	1705	126	Beef, rump. ....	45.79	54.21	.....	36.53	43.85	46.93	38.51	45.34	5.47
1652	1656	114	Veal, leg. ....	16.41	83.59	17.23	14.71	18.08	23.37	.....	.....	.....
			Average Nos. 1639, 1643, 1652, 1704, and 1721. ....	38.67	61.33	.....	28.35	30.46	37.06	35.60	24.67	3.91
			Average of all cooked 5 hours. .	35.08	64.92	9.57	15.95	25.89	29.04	42.49	24.23	3.99
			Average of all cooked for 3 and 5 hours. ....	26.12	73.88	9.57	15.13	20.06	24.70	30.06	24.23	5.13

<sup>a</sup> Average of 5 analyses.<sup>b</sup> Average of 7 analyses.

The results given in the table show that in a considerable number of cases there was no nitrogen in the form of compounds coagulated by heat, while in other cases the quantity of nitrogen in this form reached 17.17 to 21.55 per cent, the average for the 31 samples of boiled meat being 4.13 per cent.

From 6.50 to 60.60 per cent of the soluble nitrogen of boiled meats was precipitated as albumoses, the average being 19.63 per cent. the average amounts for raw meats being 4.09 per cent. (See p. 148). These figures strikingly show the hydrolyzing action of hot water upon the proteid compounds of meats, as do also the following: In meats cooked in hot water for three hours 12.90 per cent of the soluble nitrogen existed as albumose, while in the meats cooked in hot water for five hours the amount was 25.18 per cent. In meats cooked chiefly at 85° C. it was found that 17.19 per cent, and in those cooked mainly at 98.5° C. 25.59 per cent of the soluble nitrogen was in the form of albumoses.

In the 12 samples of boiled meats the average quantity of nitrogen precipitated by bromin in the filtrate from the zinc sulphate pre-

cipitate equaled 6.08 per cent of the total soluble nitrogen. The soluble proteid nitrogen ranged from 7.42 to 81.93 per cent, averaging for the 31 samples 26.12 per cent, and the nitrogen in the form of ammonium compounds was 5.13 per cent.

From the cold-water solutions of meats cooked by contact with hot water the reagents mentioned below precipitated the following amounts of nitrogen expressed in terms of the total soluble nitrogen: Bromin, 9.57 per cent; phosphotungstic acid in the hot solution, 15.13 per cent; phosphotungstic acid in the cold solution, 24.70 per cent; tannin and salt, 20.06 per cent, and Stutzer's reagent 30.06 per cent.

#### FORMS OF NITROGEN IN MEATS COOKED BY ROASTING, BROILING, SAUTÉING, AND FRYING.

In the following pages the data regarding the different forms of nitrogen existing in meats cooked by roasting, broiling, sautéing, and frying are summarized, Table 123 showing the data calculated on the basis of the total weight of the sample used.

TABLE 123.—*Nitrogen records of the cold-water extracts of meats cooked by roasting, broiling, sautéing, and frying (results expressed in percentage of meat taken).*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat and method of cooking.	Total nitrogen in meat.	Total nitrogen in water extract.	Nitrogen coagulated by heat.	Nitrogen precipitated by $\text{ZnSO}_4$ (albumose).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromin in dilute from $\text{ZnSO}_4$ precipitate.	Proteid nitrogen in water extract.
1770	1764	146	Beef, round, pot roast .....	<i>Per ct.</i> 5.972	<i>Per ct.</i> 0.4978	<i>Per ct.</i> 0.0019	<i>Per ct.</i> 0.0483	<i>Per ct.</i> 0.0502	<i>Per ct.</i> .....	<i>Per ct.</i> 0.0502
1781	1775	155	.....do.....	5.891	.4212	.0273	.0395	.0668	.....	.0668
			Average.....	5.932	.4595	.0146	.0439	.0585	.....	.0585
1771	1764	147	Beef, round, roast .....	3.870	.5567	.0915	.0279	.1194	.....	.1194
1782	1775	156	.....do.....	4.011	.4972	.1732	.0236	.1968	.....	.1968
			Average.....	3.941	.5270	.1324	.0258	.1582	.....	.1582
1660	1662	120	Veal, leg, roast .....	4.220	.4956	.0031	.0426	.0457	0.0206	.0663
			Average Nos. 1660, 1771, and 1782 .....	4.034	.5165	.0893	.0314	.1207	.....	.1275
1778	1775	152	Beef, round, gas broiled ..	4.088	.5753	.1073	.0253	.1326	.....	.1326
1766	1764	142	Beef, round, pan broiled ..	4.037	.6863	.1806	.0380	.2186	.....	.2186
1777	1775	151	.....do.....	4.435	.5693	.0648	.0288	.0936	.....	.0936
			Average Nos. 1766, 1771, and 1778 .....	4.236	.6278	.1227	.0334	.1561	.....	.1561
1674	1676	124	Beef, rump, pan broiled...	3.785	.3873	.0086	.0278	.0364	.0073	.0437
1659	1662	119	Veal, leg, pan broiled.....	4.700	.4939	.0132	.0370	.0502	.0176	.0678
			Average Nos. 1659, 1674, 1766, and 1777 ..	4.239	.5342	.0668	.0329	.0997	.0125	.1059
1765	1764	141	Beef, round, sautéed .....	4.044	.6079	.1336	.0315	.1651	.....	.1651
1776	1775	150	.....do.....	4.083	.5556	.0896	.0260	.1156	.....	.1156
			Average.....	4.064	.5818	.1116	.0288	.1404	.....	.1404

TABLE 123.—*Nitrogen records of the cold-water extracts of meats cooked by roasting, broiling, sautéing, and frying (results expressed in percentage of meat taken)*—Continued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat and method of cooking.	Total nitrogen in meat.	Total nitrogen in water extract.	Nitrogen coagulated by heat.	Nitrogen precipitated by ZnSO <sub>4</sub> (albumose).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromin in filtrate from ZnSO <sub>4</sub> precipitate.	Proteid nitrogen in water extract.
1767	1764	143	Beef, round, fried .....	<i>Per ct.</i> 4.934	<i>Per ct.</i> 0.6052	<i>Per ct.</i> 0.0526	<i>Per ct.</i> 0.0330	<i>Per ct.</i> 0.0856	<i>Per ct.</i> .....	<i>Per ct.</i> 0.0856
			Average of all beef samples .....	4.468	.5418	.0846	.0318	.1164	.....	.1171
			Average of all veal samples .....	4.460	.4948	.0082	.0398	.0480	0.0191	.0671
			Average of all beef and veal samples ..	4.467	.5346	.0728	.0330	.1059	.....	.1094
Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat and method of cooking.	Nonproteid nitrogen in water extract.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen as free ammonia.
1770	1764	146	Beef, round, pot roast ....	<i>Per ct.</i> 0.4476	<i>Per ct.</i> .....	<i>Per ct.</i> 0.0552	<i>Per ct.</i> 0.0563	<i>Per ct.</i> 0.0709	<i>Per ct.</i> 0.1366	<i>Per ct.</i> 0.0222
1781	1775	155	.....do.....	.3544	.....	.0443	.0486	.0584	.1128	.0277
			Average .....	.4010	.....	.0498	.0525	.0647	.1247	.0250
1771	1764	147	Beef, round, roast .....	.4373	.....	.1122	.1148	.1259	.1832	.0159
1782	1775	156	.....do.....	.3004	.....	.1090	.1000	.0978	.1631	.0206
			Average .....	.3689	.....	.1106	.1074	.1119	.1732	.0183
1660	1662	120	Veal, leg, roast .....	.4293	0.0249	.0305	.0398	.0283	.....	.0316
			Average Nos. 1660, 1771, and 1782 .....	.3890	.....	.0839	.0849	.0840	.1732	.0227
1778	1775	152	Beef, round, gas broiled ..	.4427	.....	.1476	.1333	.1383	.2041	.0197
1766	1764	142	Beef, round, pan broiled ..	.4677	.....	.2237	.2077	.2218	.2562	.0183
1777	1775	151	.....do.....	.4757	.....	.1011	.0840	.0995	.1610	.0213
			Average Nos. 1766, 1777, and 1778 .....	.4717	.....	.1624	.1459	.1607	.2086	.0198
1674	1676	124	Beef, rump, pan broiled...	.3436	.0245	.0389	.0008	.0204	.....	.0185
1659	1662	119	Veal, leg, pan broiled .....	.4261	.0401	.0449	.0259	.0084	.....	.0246
			Average Nos. 1659, 1674, 1766, and 1777.	.4283	.0323	.1022	.0796	.0876	.2086	.0207
1765	1764	141	Beef, round, sautéed .....	.4428	.....	.1678	.1653	.1655	.2114	.0166
1776	1775	150	.....do.....	.4400	.....	.1141	.1149	.1238	.1799	.0198
			Average .....	.4414	.....	.1410	.1401	.1447	.1957	.0182
1767	1764	143	Beef, round, fried .....	.5196	.....	.0909	.0933	.1007	.1715	.0202
			Average of all beef samples .....	.4247	.....	.1095	.1017	.1112	a. 1780	.0201
			Average of all veal samples .....	.4277	.....	.0377	.0329	.0184	.....	.0281
			Average of all beef and veal samples ..	.4252	.0298	.0985	.0911	.0969	.1780	.0213

a Average of 10 analyses.

Upon examining the data it will be seen that the total nitrogen in meats cooked by dry heat varied from 3.785 per cent in pan broiled beef rump (sample No. 1674) to 5.972 per cent in a beef round pot roast (sample No. 1770), the average being 4.467 per cent.

The total nitrogen soluble in cold water was 0.3873 to 0.6863 per cent, the average being 0.5346 per cent.

The nitrogen in the form of soluble proteids coagulated by heat ranged from 0.0019 to 0.1806 per cent, the average being 0.0728 per cent.

The average amount of albumose nitrogen in the cold-water extracts was 0.0330 per cent, the soluble proteid nitrogen 0.0437 to 0.2186 per cent, the average being 0.1094 per cent, and the non-proteid nitrogen 0.3004 to 0.5196 per cent, the average being 0.4252 per cent.

The results of the analyses reported show that there is a small amount of nitrogen present as ammonium salts in the cold-water extracts of meats cooked by dry heat, the average for the thirteen determinations being 0.0213 per cent.

The other reagents used to separate the nitrogenous constituents of the cold-water extracts of meats cooked by dry heat gave results as follows: Bromin, 0.0298 per cent; phosphotungstic acid in a hot solution, 0.0985 per cent; phosphotungstic acid in a cold solution, 0.0969 per cent; tannin and salt, 0.0911 per cent, and Stutzer's reagent 0.1780 per cent.

In the case of raw as compared with fried meat (veal cutlet), Offer and Rosenquist<sup>a</sup> report 3.4 per cent total nitrogen and 0.53 per cent nitrogen of extractives in the raw material and 4.38 per cent and 0.506 per cent, respectively, in the cutlet fried in a little butter.

In Table 124 the nitrogen values for the meats cooked by dry heat in the Illinois experiments are given in the form of percentages of the total nitrogen content of the cooked flesh.

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<sup>a</sup> Berlin. Klin. Wehnschr., 36 (1899), p. 1086.

TABLE 124.—*Nitrogen records of the cold-water extracts of meats cooked by roasting, broiling, sautéing, and frying (results expressed in percentage of total nitrogen of meat taken).*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat and method of cooking.	Total nitrogen in meat.	Total nitrogen in water extract.	Nitrogen coagulated by heat.	Nitrogen precipitated by $\text{ZnSO}_4$ (albumose).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromin in filtrate from $\text{ZnSO}_4$ precipitate.	Proteid nitrogen in water extract.
				<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1770	1764	146	Beef, round, pot roast . . .	100	8.34	0.03	0.81	0.84	.....	0.84
1781	1775	155	.....do.....	100	7.15	.46	.67	1.13	.....	1.13
			Average.....	100	7.75	.25	.74	.99	.....	.99
1771	1764	157	Beef, round, roast.....	100	14.38	2.36	.72	3.08	.....	3.08
1782	1775	156	.....do.....	100	12.40	4.32	.59	4.91	.....	4.91
			Average.....	100	13.39	3.34	.66	4.00	.....	4.00
1660	1662	120	Veal, leg, roast.....	100	11.74	.07	1.01	1.08	0.49	1.57
			Average Nos. 1660, 1771, and 1782.....	100	12.84	2.25	.77	3.02	.....	3.19
1778	1775	152	Beef, round, gas broiled...	100	14.07	2.62	.62	3.24	.....	3.24
1766	1764	142	Beef, round, pan broiled...	100	17.00	4.47	.94	5.41	.....	5.41
1777	1775	151	.....do.....	100	12.84	1.46	.65	2.11	.....	2.11
			Average Nos. 1766 and 1777.....	100	14.92	2.97	.80	3.76	.....	3.76
1674	1676	124	Beef, rump, pan broiled...	100	10.23	.23	.73	.96	.19	1.15
1659	1662	119	Veal, leg, pan broiled.....	100	10.51	.28	.79	1.07	.37	1.44
			Average Nos. 1659, 1674, 1766, and 1777.	100	12.64	1.61	.78	2.39	.28	2.53
1765	1764	141	Beef, round, sautéed.....	100	15.03	3.30	.78	4.08	.....	4.08
1776	1775	150	.....do.....	100	13.61	2.19	.64	2.83	.....	2.83
			Average.....	100	14.32	2.75	.71	3.46	.....	3.46
1767	1764	143	Beef, round, fried.....	100	12.27	1.07	.67	1.74	.....	1.74
			Average of all beef samples.....	100	12.48	2.05	.71	2.76	.19	2.78
			Average of all veal samples.....	100	11.13	.18	.90	1.08	.43	1.51
			Average of all beef and veal samples..	100	12.27	1.76	.74	2.50	.....	2.58

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat and method of cooking.	Nonproteid nitrogen in water extract.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold.)	Nitrogen precipitated by Stutzer's reagent.	Nitrogen as free ammonia.
				<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1770	1764	146	Beef, round, pot roast . . .	7.50	.....	0.92	0.94	1.19	2.29	0.37
1781	1775	155	.....do.....	6.02	.....	.75	.83	.99	1.91	.47
			Average.....	6.76	.....	.84	.89	1.09	2.10	.42
1771	1764	157	Beef, round, roast.....	11.30	.....	2.90	2.96	3.25	4.73	.41
1782	1775	156	.....do.....	7.49	.....	2.72	2.50	2.44	4.07	.51
			Average.....	9.39	.....	2.81	2.73	2.85	4.40	.46



TABLE 124.—*Nitrogen records of the cold-water extracts of meats cooked by roasting, broiling, sautéing, and frying (results expressed in percentage of total nitrogen of meat taken).—Continued.*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat and method of cooking.	Nonproteid nitrogen in water extract.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen as free ammonia.
1660	1662	120	Veal, leg, roast.....	Per ct. 10.17	Per ct. 0.59	Per ct. 0.72	Per ct. 0.94	Per ct. 0.67	Per ct. .....	Per ct. 0.75
			Average Nos. 1660, 1771, and 1782.....	9.65	.....	2.11	2.13	2.12	.....	.56
1778	1775	152	Beef, round, gas broiled...	10.83	.....	3.61	3.26	3.38	4.99	.48
1766	1764	142	Beef, round, pan broiled...	11.59	.....	5.54	5.15	5.49	6.35	.45
1777	1775	151	do.....	10.73	.....	2.28	1.90	2.25	3.63	.48
			Average Nos. 1766 and 1777.....	11.16	.....	3.91	3.53	3.87	4.99	.47
1674	1676	124	Beef, rump, pan broiled...	9.08	0.65	1.03	.02	.54	.....	.49
1659	1662	119	Veal leg, pan broiled.....	9.07	.85	.96	.55	.18	.....	.52
			Average Nos. 1659, 1674, 1766, and 1777.....	10.11	.....	2.45	1.91	2.12	.....	.49
1765	1764	141	Beef, round, sautéed.....	10.95	.....	4.15	4.09	4.09	5.23	.41
1776	1775	150	do.....	10.78	.....	2.79	2.82	3.03	4.41	.49
			Average.....	10.86	.....	3.47	3.46	3.56	4.82	.45
1767	1764	143	Beef, round, fried.....	10.53	.....	1.84	1.89	2.04	3.48	.41
			Average of all beef samples.....	9.71	.....	2.59	2.40	2.61	4.11	.45
			Average of all veal samples.....	9.62	.72	.84	.75	.43	.....	.64
			Average of all beef and veal samples.....	9.70	.70	2.32	2.15	2.27	4.11	.48

a Average of 11 analyses.

The soluble nitrogen found in meats cooked by dry heat forms 7.15 to 17 per cent of the total nitrogen contained in the cooked meat, the average being 12.27 per cent.

The average quantity of nitrogen of compounds coagulated by heat in neutral solution was 1.76 per cent; the average albumose nitrogen, 0.74 per cent; the soluble proteid nitrogen, 2.58 per cent; the nonproteid nitrogen, 6.02 to 11.59 per cent, the average being 9.70 per cent, and the nitrogen in the form of ammonia or ammonium compounds 0.48 per cent.

The other reagents employed to determine the nitrogen compounds gave the following average results: Bromin, 0.70 per cent; phosphotungstic acid in a hot solution, 2.32 per cent; phosphotungstic acid in a cold solution, 2.27 per cent; tannin and salt, 2.15 per cent, and Stutzer's reagent, 4.11 per cent.

In Table 125 the data for the nitrogen of the meats cooked by dry heat are given as percentages of the total soluble nitrogen.

TABLE 125.—*Nitrogen records of the cold-water extracts of meats cooked by roasting, broiling, sautéing, and frying (results expressed in percentage of total nitrogen in water extract).*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat and method of cooking.	Total nitrogen in meat.	Total nitrogen in water extract.	Nitrogen coagulated by heat.	Nitrogen precipitated by $\text{ZnSO}_4$ (albumose).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromin in filtrate from $\text{ZnSO}_4$ precipitate.	Proteid nitrogen in water extract.
				<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1770	1764	146	Beef, round, pot roast....	5.972	100	0.38	9.70	10.08	.....	10.08
1781	1775	155	.....do.....	5.891	100	6.48	9.38	15.86	.....	15.86
			Average.....	5.932	100	3.43	9.54	12.97	.....	12.97
1771	1764	147	Beef, round, roast.....	3.870	100	16.44	5.01	21.45	.....	21.45
1782	1775	156	.....do.....	4.011	100	34.83	4.75	39.58	.....	39.58
			Average.....	3.941	100	25.64	4.88	30.52	.....	30.52
1660	1662	120	Veal, leg, roast.....	4.220	100	.63	8.59	9.22	4.16	13.38
			Average Nos. 1660, 1771, and 1782....	4.034	100	17.30	6.12	23.42	.....	24.80
1778	1775	152	Beef, round, gas broiled..	4.088	100	18.65	4.40	23.05	.....	23.05
1766	1764	142	Beef, round, pan broiled..	4.037	100	26.31	5.54	31.85	.....	31.85
1777	1775	151	.....do.....	4.435	100	11.38	5.06	16.44	.....	16.44
			Average Nos. 1766 and 1777.....	4.236	100	18.85	5.30	24.15	.....	24.15
1674	1676	124	Beef, rump, pan broiled...	3.790	100	2.22	7.18	9.40	1.88	11.28
1659	1662	119	Veal, leg, pan broiled....	4.700	100	2.67	7.49	10.16	3.56	13.72
			Average Nos. 1659, 1674, 1766, and 1777	4.241	100	10.65	6.32	16.96	.....	18.32
1765	1764	141	Beef, round, sautéed.....	4.044	100	21.98	5.18	27.16	.....	27.16
1776	1775	150	.....do.....	4.083	100	16.13	4.68	20.81	.....	20.81
			Average.....	4.064	100	19.06	4.93	23.99	.....	23.99
1767	1764	143	Beef, round, fried.....	4.934	100	8.69	5.45	14.14	.....	14.14
			Average of all beef samples.....	4.469	100	14.86	6.03	20.89	1.88	21.06
			Average of all veal samples.....	4.460	100	1.65	8.04	9.69	3.86	13.55
			Average of all beef and veal samples..	4.468	100	12.83	6.34	19.18	.....	19.91

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat and method of cooking.	Nonproteid nitrogen in water extract.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen as free ammonia.
				<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1770	1764	146	Beef, round, pot roast....	89.92	.....	11.09	11.30	14.24	27.44	4.46
1781	1775	155	.....do.....	84.14	.....	10.52	11.54	13.87	26.78	6.58
			Average.....	87.03	.....	10.81	11.42	14.06	27.11	5.52
1771	1764	147	Beef, round, roast.....	78.55	.....	20.15	20.62	22.61	32.91	2.86
1782	1775	156	.....do.....	60.42	.....	21.92	20.11	19.67	32.80	4.14
			Average.....	69.48	.....	21.04	20.37	21.14	32.86	3.50

TABLE 125.—*Nitrogen records of the cold-water extracts of meats cooked by roasting, broiling, sautéing, and frying (results expressed in percentage of total nitrogen in water extract)—Continued.*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat and method of cooking.	Nonproteinid nitrogen in water extract.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen as free ammonia.
1660	1662	120	Veal, leg, roast.....	<i>Per ct.</i> 86.62	<i>Per ct.</i> 5.02	<i>Per ct.</i> 6.15	<i>Per ct.</i> 8.03	<i>Per ct.</i> 5.71	<i>Per ct.</i> .....	<i>Per ct.</i> 6.37
			Average Nos. 1660, 1771, and 1782.....	75.20	.....	16.07	16.25	16.00	.....	4.46
1778	1775	152	Beef, round, gas broiled...	76.95	.....	25.66	23.17	24.04	35.48	3.42
1766	1764	142	Beef, round, pan broiled...	68.15	.....	32.59	30.26	32.32	37.34	2.66
1777	1775	151	.....do.....	83.56	.....	17.76	14.76	17.48	28.28	3.74
			Average Nos. 1766 and 1777.....	75.85	.....	25.18	22.51	24.90	32.81	3.20
1674	1676	124	Beef, rump, pan broiled...	88.72	6.33	10.05	.21	5.27	.....	4.77
1659	1662	119	Veal, leg, pan broiled....	86.28	8.12	9.09	5.25	1.70	.....	4.98
			Average Nos. 1659, 1674, 1766, and 1777.	81.68	.....	17.37	12.62	14.19	.....	4.04
1765	1764	141	Beef, round, sautéed.....	72.84	.....	27.60	27.19	27.23	34.78	2.73
1776	1775	150	.....do.....	79.19	.....	20.54	20.68	22.28	37.38	3.56
			Average.....	76.02	.....	24.07	23.94	24.76	33.58	3.15
1767	1764	143	Beef, round, fried.....	85.86	.....	15.02	15.42	16.64	28.34	3.34
			Average of all beef samples.....	78.94	.....	19.35	17.75	19.60	31.65	3.84
			Average of all veal samples.....	86.45	.....	7.62	6.64	3.71	.....	5.68
			Average of all beef and veal samples..	80.09	6.49	17.55	16.04	17.16	a 31.65	4.12

a Average of 11 analyses.

The data summarized above show that 0.38 to 34.83 per cent of the soluble nitrogen of meats cooked by dry heat exists in the form of coagulable compounds, the average amount being 12.83 per cent. The nitrogen present as albumoses was 4.40 to 9.70 per cent, averaging 6.34 per cent.

The nonproteinid nitrogen ranged from 60.42 to 89.92 per cent, averaging 80.09 per cent, and the nitrogen present in the form of ammonium compounds was 4.12 per cent of the total soluble nitrogen.

From the cold-water solutions of meats cooked by dry heat the reagents mentioned below precipitated the following amounts of nitrogen: Bromin, 6.49 per cent; phosphotungstic acid in a hot solution, 17.55 per cent; phosphotungstic acid in a cold solution, 17.16 per cent; tannin and salt, 16.04 per cent; and Stutzer's reagent, 31.65 per cent.

# THE LOSSES INVOLVED IN THE BOILING AND STEWING OF MEATS.

It is interesting to consider the data regarding the kind and amount of losses sustained when meat is boiled and stewed.

The following table summarizes the results of all such experiments reported in the present bulletin, arranged according to the length of the cooking period, the method of cooking, and the kind of meat used:

TABLE 126.—Summary of the losses involved in the cooking of meats in water.

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Amount used.	Fat in cooked meat.	Method of cooking.		
					Temperature.		Duration of cooking.
					At beginning.	During cooking.	
			Grams.	Per cent.	°C.	°C.	Hours.
1642	109	Beef, round, 1-inch cubes.....	1,000	3.93	Cold.	85	3
1754	137	Beef, round, 2-inch cubes.....	900	6.80	Cold.	85	3
		Average.....		5.37	Cold.	85	3
1756	139	Beef, round, browned, 2-inch cubes.....	900	8.00	Cold.	85	3
		Average Nos. 1642, 1754, and 1756.....		6.24	Cold.	85	3
1746	136	Beef, round, browned, 2-inch cubes.....	1,000	7.12	85	85	3
1769	145	Beef, round, 2-inch cubes.....	1,074.83	6.87	85	85	3
1780	154	do.....	1,052.17	6.62	85	85	3
		Average Nos. 1769 and 1780.....		6.75	85	85	3
		Average Nos. 1746, 1769, and 1780.....		6.87	85	85	3
1641	108	Beef, round, 1-inch cubes.....	1,000	4.38	100	85	3
1744	134	Beef, round, 2-inch cubes.....	1,000	4.83	100	85	3
		Average.....		4.61	100	85	3
1768	144	Beef, round, 1 piece.....	1,027.72	7.51	100	85	3
1779	153	do.....	1,098.31	7.88	100	85	3
		Average.....		7.70	100	85	3
		Average Nos. 1641, 1744, 1768, and 1779.....		6.15	100	85	3
1755	138	Beef, round, 2-inch cubes.....	900	7.35	Cold.	100	3
1757	140	Beef, round, browned, 2-inch cubes.....	900	6.83	Cold.	100	3
		Average.....		7.09	Cold.	100	3
1743	133	Beef, round, lean, 2-inch cubes.....	1,000	5.06	100	100	3
1745	135	Beef, round, lean, browned, 2-inch cubes.....	1,000	7.74	100	100	3
		Average.....		6.40	100	100	3
		Average of all cooked 3 hours.....		6.49			3
1646	113	Beef, round, ¾-inch cubes.....	1,000	5.57	Cold.	65	5
1645	112	do.....	1,000	5.23	Cold.	85	5
1654	116	Veal, leg, 1-inch cubes.....	1,000	.97	Cold.	85	5
1658	118	do.....	1,000	5.58	Cold.	85	5
		Average Nos. 1654 and 1658.....		3.28	Cold.	85	5
		Average Nos. 1645, 1654, and 1658.....		3.93	Cold.	85	5
1644	111	Beef, round, ¾-inch cubes.....	1,000	5.75	100	85	5
1720	131	Beef, round, 1-inch cubes.....	1,000	11.61	100	85	5
		Average.....		8.68	100	85	5

TABLE 126.—Summary of the losses involved in the cooking of meats in water—Continued.

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Amount used.	Fat in cooked meat.	Method of cooking.		
					Temperature.		Duration of cooking.
					At beginning.	During cooking.	
			Grams.	Per cent.	°C.	°C.	Hours.
1665	121	Beef, neck, ¾-inch cubes.....	700	13.68	100	85	5
1673	123	Beef, rump, 1-inch cubes.....	1,000	42.03	100	85	5
1703	125	.....do.....	1,000	23.36	100	85	5
		Average Nos. 1673 and 1703.....		32.70	100	85	5
1669	122	Beef, flank, fat, ¾-inch cubes.....	1,000	34.16	100	85	5
1653	115	Veal, leg, 1-inch cubes.....	1,000	1.31	100	85	5
1664	117	.....do.....	1,000	7.77	100	85	5
		Average Nos. 1653 and 1664.....		4.54	100	85	5
		Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....		17.46	100	85	5
1639	107	Beef, round, 1-inch cubes.....	1,000		100	100	5
1643	110	Beef, round, ¾-inch cubes.....	1,000	5.66	100	100	5
1721	132	Beef, round, 1-inch cubes.....	1,000	9.01	100	100	5
		Average.....		7.34	100	100	5
1704	126	Beef, rump, 1-inch cubes.....	1,000	16.07	100	100	5
1652	114	Veal, leg, 1-inch cubes.....	1,000	1.59	100	100	5
		Average Nos. 1639, 1643, 1652, 1704, and 1721.....		8.08	100	100	5
		Average of all cooked 5 hours.....		11.84			5
		Average of all cooked 3 and 5 hours.....		9.34			

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Nutrients in the broth expressed in percentages of total amounts in uncooked meat.					
			Water.	Proteid.	Organic extractives.		Fat.	Ash.
					Nitrogenous.	Non-nitrogenous.		
			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct. <sup>3</sup>
1642	109	Beef, round, 1-inch cubes.....	58.09	7.87	82.07	82.19	22.60	74.54
1754	137	Beef, round, 2-inch cubes.....	58.56	2.79	67.33	70.65	19.17	61.49
		Average.....	58.33	5.33	74.70	76.42	20.89	68.02
1756	139	Beef, round, browned, 2-inch cubes..	54.19	1.66	66.84	71.10	11.24	61.40
		Average Nos. 1642, 1754, and 1756.....	56.95	4.11	72.08	74.65	17.68	65.81
1746	136	Beef, round, browned, 2-inch cubes..	55.76	1.78	67.23	68.31	28.95	60.80
1769	145	Beef, round, 2-inch cubes.....	57.97	1.29	59.12	63.41	10.43	51.14
1780	154	.....do.....		1.29	63.48	64.88		54.00
		Average Nos. 1769 and 1780.....		1.29	61.30	64.15		52.57
		Average Nos. 1746, 1769, and 1780.....		1.45	63.28	65.53		55.31
1641	108	Beef, round, 1-inch cubes.....	57.18	3.21	85.80	84.94	20.65	73.93
1744	134	Beef, round, 2-inch cubes.....	57.42	1.71	66.92	66.89	10.66	60.79
		Average.....	57.30	2.46	76.36	75.92	15.66	67.36
1768	144	Beef, round, 1 piece.....	49.23	1.03	52.19	47.94	3.52	45.50
1779	153	.....do.....	58.37	.93	58.56	60.30	8.03	52.65
		Average.....	53.80	.98	55.38	54.12	5.78	49.08
		Average Nos. 1641, 1744, 1768, and 1779.....	55.55	1.72	65.87	65.02	10.72	58.22



TABLE 126.—*Summary of the losses involved in the cooking of meats in water—Continued.*

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Nutrients in the broth expressed in percentages of total amounts in uncooked meats.					
			Water.	Proteid.	Organic extractives.		Fat.	Ash.
					Nitrogenous.	Non-nitrogenous.		
1755	138	Beef, round, 2-inch cubes.....	<i>Per ct.</i> 57.91	<i>Per ct.</i> 2.95	<i>Per ct.</i> 69.11	<i>Per ct.</i> 68.73	<i>Per ct.</i> 29.04	<i>Per ct.</i> 62.43
1757	140	Beef, round, browned, 2-inch cubes..	57.04	1.89	67.20	68.37	14.71	62.24
		Average.....	57.48	2.42	68.16	68.55	21.88	62.34
1743	133	Beef, round, lean, 2-inch cubes.....	56.89	2.02	67.76	66.07	14.14	60.51
1745	135	Beef, round, lean, browned, 2-inch cubes.....	54.60	2.25	66.97	70.64	36.35	58.22
		Average.....	55.75	2.14	67.37	68.36	25.25	59.37
		Average of all cooked 3 hours.....	56.40	2.33	67.19	68.17	17.66	59.97
1646	113	Beef, round, 3-inch cubes.....	54.09	4.88	85.24	85.16	18.64	70.96
1645	112	.....do.....	59.74	4.56	86.01	85.38	30.24	72.09
1654	116	Veal, leg, 1-inch cubes.....	48.30	5.25	81.64	66.88	24.83	62.40
1658	118	.....do.....	50.94	5.75	75.77	75.24	13.43	65.12
		Average Nos. 1654 and 1658.....	49.62	5.50	78.71	71.06	19.13	63.76
		Average Nos. 1645, 1654, and 1658.....	52.99	5.19	81.14	75.83	22.83	66.74
1644	111	Beef, round, 3-inch cubes.....	57.66	3.02	81.21	79.82	21.79	65.64
1720	131	Beef, round, 1-inch cubes.....	56.84	2.35	72.55	94.15	16.48	69.46
		Average.....	57.25	2.69	76.88	86.99	19.14	67.55
1665	121	Beef, neck, 3-inch cubes.....					11.93	72.15
1673	123	Beef, rump, 1-inch cubes.....	52.16	3.91	66.70	75.53	18.95	70.10
1703	125	.....do.....	55.00	2.68	83.30	83.56	14.50	69.88
		Average Nos. 1673 and 1703.....	53.58	3.30	75.00	79.55	16.73	69.99
1669	122	Beef, flank, fat, 3-inch cubes.....	39.25	4.76	95.25	86.11	21.31	72.23
1653	115	Veal, leg, 1-inch cubes.....	48.92	2.62	67.46	65.68	6.86	58.48
1664	117	.....do.....	50.78	3.52	70.13	67.01	6.73	61.23
		Average Nos. 1653 and 1664.....	49.85	3.07	68.80	66.35	6.80	59.86
		Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	51.51	3.27	76.66	78.84	14.82	67.40
1639	107	Beef, round, 1-inch cubes.....	56.41	2.70	77.35	66.00		60.88
1643	110	Beef, round, 3-inch cubes.....	55.41	3.34	78.42	77.78	21.48	61.17
1721	132	Beef, round, 1-inch cubes.....	56.29	3.86	71.16	82.25	18.64	63.07
		Average.....	56.04	3.30	75.64	75.34	20.06	61.71
1704	126	Beef, rump, 1-inch cubes.....	54.42	6.09	71.30	69.78	25.36	57.83
1652	114	Veal, leg, 1-inch cubes.....	49.78	3.59	50.19	49.23	6.74	45.98
		Average Nos. 1639, 1643, 1652, 1704, and 1721.....	54.46	3.92	69.68	69.01	18.06	57.79
		Average of all cooked 5 hours.....	52.87	3.93	75.85	75.60	17.37	64.66
		Average of all cooked 3 and 5 hours.....	54.45	3.18	71.81	72.13	17.50	62.55

TABLE 126.—*Summary of the losses involved in the cooking of meats in water—Continued.*

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Nutrients in broth expressed in percentages of total weight of the uncooked meat.						
			Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.
					Nitrogenous.	Non-nitrogenous.			
1642	109	Beef, round, 1-inch cubes	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1754	137	Beef, round, 2-inch cubes	42.97	1.56	1.02	1.34	0.59	0.77	48.25
			42.54	.54	.86	1.06	.86	.60	46.46
		Average	42.76	1.05	.94	1.20	.73	.69	47.37
1756	139	Beef, round, browned, 2-inch cubes	38.98	.32	.87	1.06	.58	.61	42.42
		Average Nos. 1642, 1754, and 1756	41.50	.81	.92	1.15	.68	.66	45.72
1746	136	Beef, round, browned, 2-inch cubes	39.73	.35	.84	1.10	1.62	.61	44.25
1769	145	Beef, round, 2-inch cubes	42.57	.25	.75	.83	.44	.52	45.36
1780	154	do		.25	.73	.90		.53	
		Average Nos. 1769 and 1780		.25	.74	.87		.53	
		Average Nos. 1746, 1769, and 1780		.28	.77	.94		.55	
1641	108	Beef, round, 1-inch cubes	42.12	.64	1.06	1.36	.61	.76	46.55
1744	134	Beef, round, 2-inch cubes	42.38	.33	.87	1.19	.31	.61	45.69
		Average	42.25	.49	.97	1.28	.46	.69	46.14
1768	144	Beef, round, 1 piece	35.50	.20	.67	.73	.17	.46	37.73
1779	153	do	42.00	.19	.73	.87	.38	.52	44.69
		Average	38.75	.20	.70	.80	.28	.49	41.22
		Average Nos. 1641, 1744, 1768, and 1779	40.50	.34	.83	1.04	.37	.59	43.67
1755	138	Beef, round, 2-inch cubes	41.52	.57	.89	1.06	1.62	.63	46.29
1757	140	Beef, round, browned, 2-inch cubes	41.29	.37	.89	1.08	.65	.64	44.92
		Average	41.41	.47	.89	1.07	1.14	.64	45.62
1743	133	Beef, round, lean, 2-inch cubes	41.71	.39	.89	1.11	.46	.62	45.18
1745	135	Beef, round, lean, browned, 2-inch cubes	38.57	.43	.82	1.07	2.48	.57	43.94
		Average	40.14	.41	.86	1.09	1.47	.60	44.56
		Average of all cooked 3 hours	40.92	.46	.85	1.05	.83	.61	44.76
1646	113	Beef, round, ¾-inch cubes	40.68	.91	.92	1.19	.70	.74	45.14
1645	112	do	44.72	.80	.99	1.27	1.14	.72	49.64
1654	116	Veal, leg, 1-inch cubes	37.61	1.01	.76	1.14	.19	.62	41.33
1658	118	do	38.60	1.02	.79	.96	.50	.63	42.50
		Average Nos. 1654 and 1658	38.11	1.02	.78	1.05	.35	.63	41.92
		Average Nos. 1645, 1654, and 1658	40.31	.94	.85	1.12	.61	.66	44.49
1644	111	Beef, round, ¾-inch cubes	42.72	.56	.92	1.20	.85	.70	46.95
1720	131	Beef, round, 1-inch cubes	40.20	.42	.95	1.34	1.26	.64	44.81
		Average	41.46	.49	.94	1.27	1.06	.67	45.88
1665	121	Beef, neck, ¾-inch cubes		2.09			1.02	.67	
1673	123	Beef, rump, 1-inch cubes	26.90	.51	.61	.86	6.32	.50	35.70
1703	125	do	35.18	.45	.86	1.03	2.36	.59	40.47
		Average Nos. 1673 and 1703	31.04	.48	.74	.95	4.34	.55	38.09

TABLE 126.—*Summary of the losses involved in the cooking of meats in water—Continued.*

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Nutrients in broth expressed in percentages of total weight of the uncooked meat.						
			Water.	Proteid.	Organic extractives.		Fat.	Ash.	Total solid matter.
					Nitrogenous.	Non-nitrogenous.			
1669	122	Beef, flank, fat, $\frac{3}{4}$ -inch cubes.	<i>Per ct.</i> 21.03	<i>Per ct.</i> 0.70	<i>Per ct.</i> 0.56	<i>Per ct.</i> 0.74	<i>Per ct.</i> 6.48	<i>Per ct.</i> 0.44	<i>Per ct.</i> 29.95
1653	115	Veal, leg, 1-inch cubes.	37.73	.51	.85	1.13	.06	.62	40.90
1664	117	.....do.....	37.69	.64	.78	.91	.33	.62	40.97
		Average Nos. 1653 and 1664.....	37.71	.58	.82	1.02	.20	.62	40.94
		Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	34.49	.74	.79	1.03	2.34	.60	39.97
1639	107	Beef, round, 1-inch cubes..	41.80	.52	.89	1.25	.74	.67	45.87
1643	110	Beef, round, $\frac{3}{4}$ -inch cubes....	41.18	.62	.88	1.09	.85	.64	45.26
1721	132	Beef, round, 1-inch cubes....	40.44	.71	.88	1.27	1.14	.59	45.03
		Average.....	41.14	.62	.88	1.20	.91	.63	45.39
1704	126	Beef, rump, 1-inch cubes....	37.14	1.01	.75	.94	3.09	.53	43.46
1652	114	Veal, leg, 1-inch cubes.....	37.96	.68	.67	.96	.07	.51	40.85
		Average Nos. 1639, 1643, 1652, 1704, and 1721.....	39.70	.71	.81	1.10	1.18	.59	44.09
		Average of all cooked 5 hours.....	37.60	.78	.82	1.08	1.59	.61	42.43
		Average of all cooked 3 and 5 hours.....	39.09	.63	.83	1.07	1.24	.61	43.47

In the thirty-one experiments here reported with meat cooked in hot water the total losses in weight varied from 29.95 to 49.64 per cent of the total weight of the fresh meat used, the average being 43.47 per cent. The smallest loss was observed in experiment No. 122, in which a cut of fat beef flank was cooked for ten minutes in boiling water, and then at a temperature of 85° C. for five hours; and the largest loss was in experiment No. 112, in which lean beef round was put in cold water, which was heated slowly so that the temperature reached 85° C. at the end of one hour, and the cooking then continued for five hours more at this temperature. The data summarized also show that the greater part of the loss occurring in boiling meats was due to the removal of water, though there was also a considerable loss of nutrients, including proteids, nitrogenous and non-nitrogenous extractives, fat, and ash.

The amount of water removed during cooking varied from 39.25 to 59.74 per cent, and averaged 54.45 of the total in the uncooked meat. The smallest loss was noted in experiment No. 122, and the largest in experiment No. 112, which is in accordance with the statement in the paragraph above.

The total proteid recovered in the broth ranged from 0.93 to 7.87 per cent, averaging 3.18 per cent of the total amount present in the

raw meat. The smallest loss of this constituent was found in experiment No. 153 in which a piece of lean beef round, cut about 5 inches thick and 4 inches across, was cooked for ten minutes in boiling water, and then at a temperature of 85° C. for three hours; and the greatest loss was in experiment No. 109, in which lean beef round, cut into 1-inch cubes, was cooked by putting it into cold water at first, then heating slowly so that the temperature reached 85° C. at the end of one hour, and finally cooking for three hours more at this temperature.

The proportion of fat originally present in the raw meat which was recovered in the broth varied from 3.52 to 36.35 per cent, averaging 17.50 per cent. The smallest loss was noted in experiment No. 144, in which a piece of lean beef round, cut about 5 inches thick and 4 inches across, was placed for ten minutes in boiling water, and then cooked at a temperature of 85° C. for three hours. The largest loss was observed in experiment No. 135, in which lean beef round in the form of cubes was browned in a small amount of fat and then cooked in water at about 100° C. for three hours.

The amount of nitrogenous organic extractives removed during the cooking varied from 50.19 to 95.25 per cent, averaging 71.81 per cent of the total amount originally present.

The proportion of the nonnitrogenous organic extractives recovered in the broth ranged from 49.23 to 94.15 per cent, the average being 72.13 per cent.

The mineral substances recovered in the broth varied from 45.50 to 74.54 per cent, the average being 62.55 per cent.

In a former bulletin<sup>a</sup> of this Office a summary of the results of 91 experiments with meat cooked in hot water made in this laboratory up to that time was given. The most important conclusions derived from these experiments were that (1) the total losses in weight when meat was cooked in hot water varied in individual tests from 10.61 to 50.20 per cent of the total weight of the fresh meat used, the average being 34.35 per cent. (2) The amount of water removed during cooking varied from 18.05 to 68.90 per cent and averaged 45.07 per cent of the total water in the uncooked meat. (3) The total protein removed in the broth varied from 3.25 to 12.67 per cent, averaging 7.25 per cent. (4) The proportion of fat originally present in the raw meat, which was recovered in the broth, varied from 0.60 to 37.40 per cent. (5) The mineral matter recovered in the broth varied from 20.04 to 67.39 per cent of the total in the uncooked meat, averaging 44.63 per cent. (6) The nutrients in the broth expressed in percentages of the total weight of the uncooked meat were on an average as follows: Water, 30.75; proteid, 1.41; fat, 1.21; and ash,

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<sup>a</sup> U. S. Dept. Agr., Office of Experiment Stations Bul. 141.

0.46 per cent. (7) The fatter kinds and cuts of meat lost less water, protein, and mineral matter, but more fat than did the leaner kinds and cuts. (8) The losses increased in proportion to the extent of cooking; that is to say, other things being the same, the longer the time and the higher the temperature of cooking, the greater the losses resulting. (9) The different cuts of the same kind of meat behaved very differently as regards the amount and nature of the losses which they underwent when cooked in hot water. (10) The larger the piece of meat the smaller relatively the losses. (11) When meat is cooked in water at 80° to 85° C., placing the meat in hot or in cold water at the start had little effect on the amount of material found in the broth. (12) Beef which has been used for the preparation of beef tea or broth has lost comparatively little in nutritive value, though much of the flavoring material has been removed.

Comparing the average results obtained in the thirty-one experiments here reported with the average results obtained in previous work, it will be noted that the losses of water, fat, and ash in the former tests are considerably greater and the loss of proteid much less than in the latter. The greater losses of water, fat, and ash in the experiments reported in the present bulletin are undoubtedly due to the fact that, with two exceptions, all the meats used for cooking were cut into small cubes varying in size from 0.75 to 2 inches. In the ninety-one experiments previously reported most of the meats used were in solid pieces of considerable size, weighing as a rule from 2 to 6 pounds. The former experiments proved conclusively that the larger the piece of meat cooked by boiling the smaller the relative losses. The smaller apparent losses of proteid materials in the present experiments is due to the fact that a distinction has been made between proteid, nitrogenous extractives, and nonnitrogenous extractives, while in the former experiments these three different classes of substances were all classed under the general term protein.

The experiments summarized in Table 126 confirm the conclusions drawn from the earlier experiments, that the amount of material recovered in the broth when meat is cooked in hot water depends directly upon the length of time of cooking. The average losses in the fourteen cooking experiments in which the meats were cooked for three hours, were: 56.40 per cent water, 2.33 per cent proteid, 67.19 per cent nitrogenous extractives, 68.17 per cent nonnitrogenous extractives, 17.65 per cent fat, and 59.97 per cent ash. The average losses in the seventeen cooking experiments in which the meats were cooked for five hours were: 52.87 per cent water, 3.93 per cent proteid, 75.85 per cent nitrogenous extractives, 75.60 per cent non-nitrogenous extractives, 17.37 per cent fat, and 64.66 per cent ash.



It should also be mentioned in this connection that the average amount of fat in the meats cooked for three hours was only 6.49 per cent, while in the meats cooked for five hours it was 11.84 per cent.

Nothwang,<sup>a</sup> working in Rubner's laboratory, found that on cooking flesh in water at 100° C. from 57 to 60 parts of cooked meat were obtained from 100 parts of the flesh. Of this, 3 to 5 parts were made up of the solid matter suspended in the water in which the meat was boiled. In the broth he found some coagulated albumin and fat as a scum, gelatin, flesh bases (up to 50 per cent of the amount contained in the fresh meat), and four-fifths of the total salts of the meat.

The influence of the size of the piece of meat upon the resulting losses is strikingly shown in cooking experiments Nos. 144 and 153. In these two experiments the lean beef round was cut into pieces about 5 inches thick and 4 inches across, while the meat used in all the other boiling experiments here reported was in the form of small cubes. The losses resulting in experiments Nos. 144 and 153 were considerably less than those occurring in any of the other experiments. This would indicate the advantage of cutting the meat into small pieces in the preparation of soups and broths. On the other hand, the meat itself will be more juicy, better flavored, and of superior nutritive value if cooked in large pieces.

From the data here given it does not seem wise to draw final conclusions regarding the influence of the kind of meat, the fat content, and the different cuts of the same kind of meat upon the amount and nature of the losses sustained when cooked in hot water.

#### **THE LOSSES INVOLVED IN THE ROASTING, BROILING, SAUTÉING, AND FRYING OF MEATS.**

A summary of the results obtained in the experiments in which meats were cooked by dry heat is given in the following table, which includes the data concerning the kind of meat used, the time of cooking, and the apparent losses or gains of the different nutrients expressed as percentages of the total amounts of the corresponding nutrients in the uncooked meat and as percentages of the total quantity of meat cooked.

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<sup>a</sup> Arch. Hyg., 18 (1893), p. 80.

TABLE 127.—Summary of the losses involved in the cooking of meats by roasting, broiling, sautéing, and frying.

Lab- ora- tory No.	Cook- ing ex- per- iment No.	Kind of meat used for cooking.	Amount taken.	Fat in cooked meat.	Method of cooking.					
					Kind.	Total time.		Tem- pera- ture at be- gin- ning.	Final cooking.	
						h.	m.		°C.	°C.
1770 1781	146 155	Beef, round..... .....do.....  Average.....	Grams. 966.87 1,041.33  1,004.10	Per ct. 9.66 9.87  9.77	Pot roast..... .....do.....  .....	3 3  3	   	   	   	   
1771 1782	147 156	Beef, round..... .....do.....  Average.....	1,104.40 1,110.88  1,107.64	9.50 5.42  7.46	Roast..... .....do.....  .....	1 1  3	   	249 249  	193 193  	45 45  
1660	120	Veal, leg.....  Average Nos. 1660, 1771, and 1782.	1,099.00  1,104.76	4.65  6.52	Roast.....  .....	3  	  	  	  	  
1778 1766 1777	152 142 151	Beef, round..... .....do..... .....do.....  Average Nos. 1766 and 1777.	662.97 673.91 664.60  660.26	7.64 8.18 5.83  7.01	Gas broiled... Pan broiled... .....do.....  .....	10 10 10  	   	   	   	   
1674 1659	124 119	Beef, rump..... Veal, leg.....  Average Nos. 1659, 1674, 1766, and 1777.	571.12 572.72  620.59	47.39 5.20  16.65	Pan broiled... .....do.....  .....	13 15  	   	   	   	   
1765 1776	141 150	Beef, round..... .....do.....  Average.....	670.54 641.09  655.82	9.88 6.34  8.11	Sautéed..... .....do.....  .....	10 10  	   	   	   	   
1767	143	Beef, round.....  Average of all beef samples.  Average of all veal samples.  Average of all beef and veal samples.	666.11       	10.42       	Fried.....       	       	10       	200       	160       	10       
Lab- ora- tory No.	Cook- ing ex- per- iment No.	Kind of meat used for cooking.	Loss or gain of each nutrient, expressed in percentages, of the weight of the uncooked meat.							
			Water.	Proteid.	Organic extractives.		Fat.	Ash.		
					Nitrog- enous.	Non- nitrog- enous.				
1770 1781	146 155	Beef, round..... .....do.....  Average.....	Per cent. -40.63 -44.87  -42.75	Per cent. +1.51 - .11  + .70	Per cent. -0.39 - .54  - .47	Per cent. -0.78 - .77  - .78	Per cent. -2.70 + .39  -1.16	Per ct. -0.38 - .49  - .44		
1771 1782	147 156	Beef, round..... .....do.....  Average.....	-16.03 -15.53  -15.78	- .07 + .86  + .40	- .05 - .34  - .20	- .44 - .33  - .39	- .23 - .35  - .29	- .09 - .11  - .10		
1660	210	Veal, leg.....  Average Nos. 1660, 1771, and 1782.	-22.41  -17.99	+ .39  + .39	- .04  - .14	+ .10  - .22	- .38  - .32	- .04  - .08		

TABLE 127.—Summary of the losses involved in the cooking of meats by roasting, broiling, sautéing, and frying—Continued.

Lab- ora- tory No.	Cook- ing ex- peri- ment No.	Kind of meat used for cooking.	Loss or gain of each nutrient, expressed in percentages, of the weight of the uncooked meat.					
			Water.	Proteid.	Organic extractives.		Fat.	Ash.
					Nitrog- enous.	Non- nitrog- enous.		
			<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1778	152	Beef, round.....	-18.12	+0.29	+0.02	-0.05	+1.45	-0.08
1766	142	.....do.....	-15.07	+ .69	+ .04	- .29	-1.31	- .07
1777	151	.....do.....	-20.26	+1.29	+ .06	- .01	- .21	- .09
		Average Nos. 1766 and 1777.....	-17.67	+ .99	+ .05	- .15	- .76	- .08
1674	124	Beef, rump.....	-34.54	+ .19	+ .03	- .02	-1.80	+ .02
1659	119	Veal, leg.....	-29.98	+ .61	- .15	- .09	- .36	- .10
		Average Nos. 1659, 1674, 1766, and 1777...	-24.96	+ .70	- .01	- .10	- .92	- .06
1765	141	Beef, round.....	-15.84	+1.05	- .01	- .30	+ .20	- .06
1776	150	.....do.....	-16.11	+ .86	+ .05	- .02	+ .53	- .09
		Average.....	-15.98	+ .96	+ .02	- .16	+ .37	- .08
1767	143	Beef, round.....	-29.06	+1.55	- .03	- .44	- .78	- .05
		Average of all beef samples.....	-24.19	+ .74	- .11	- .32	- .64	- .14
		Average of all veal samples.....	-26.20	+ .50	- .10	+ .01	- .37	- .07
		Average of all beef and veal samples.....	-24.50	+ .70	- .10	- .27	- .43	- .13

Lab- ora- tory No.	Cook- ing ex- peri- ment No.	Kind of meat used for cooking.	Loss or gain of nutrients, expressed in percentages, of total amounts in uncooked meat.					
			Water.	Proteid.	Organic extractives		Fat.	Ash.
					Nitrog- enous.	Non- nitrog- enous.		
			<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per ct.</i>
1770	146	Beef, round.....	-58.11	+8.39	-33.13	-44.95	-33.20	-35.61
1781	153	.....do.....	-61.23	- .57	-47.83	-55.14	+ 7.84	-45.37
		Average.....	-59.67	+3.91	-40.48	-50.05	-12.68	-40.49
1771	147	Beef, round.....	-22.92	- .41	- 3.91	-25.33	- 2.80	- 8.03
1782	156	.....do.....	-21.19	+4.60	-29.96	-23.60	- 7.04	-10.40
		Average.....	-22.06	-2.10	-16.94	-24.47	- 4.92	- 9.22
1660	120	Veal, leg.....	-29.66	+2.18	- 3.54	+ 7.17	- 9.42	- 3.89
		Average Nos. 1660, 1771, and 1782.....	-24.59	+2.12	-12.47	-13.92	- 6.42	- 7.44
1778	152	Beef, round.....	-24.72	+1.58	+ 1.74	- 3.66	+29.55	- 6.92
1766	142	.....do.....	-21.56	+3.85	+ 3.52	-16.90	-16.10	- 6.16
1777	151	.....do.....	-27.64	+6.88	+ 5.59	- .86	- 4.23	- 8.15
		Average Nos. 1766 and 1777.....	-24.60	+5.37	+ 4.56	- 8.88	-10.17	- 7.16
1674	124	Beef, rump.....	-66.10	+1.37	+ 4.51	- 2.58	- 5.57	+ 2.84
1659	119	Veal, leg.....	-39.69	+3.36	-14.22	-6.37	- 9.10	- 8.73
		Average Nos. 1659, 1674, 1766, and 1777...	-38.75	+3.87	- .15	- 6.68	- 8.75	-5.05
1765	141	Beef, round.....	-22.64	+5.87	- 1.14	-17.50	+ 2.40	- 6.05
1776	150	.....do.....	-21.98	+4.60	+ 4.01	- 1.45	+10.74	- 8.01
		Average.....	-22.31	+5.24	+ 1.44	- 9.48	+ 6.57	- 7.03

TABLE 127.—*Summary of the losses involved in the cooking of meats by roasting, broiling, sautéing, and frying—Continued.*

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Loss or gain of nutrients, expressed in percentages, of total amounts in uncooked meat.					
			Water.	Proteid.	Organic extractives.		Fat.	Ash.
					Nitrogenous.	Non-nitrogenous.		
1767	143	Beef, round .....	<i>Per cent.</i> -41.56	<i>Per cent.</i> +8.64	<i>Per cent.</i> - 2.93	<i>Per cent.</i> -25.17	<i>Per cent.</i> - 9.58	<i>Per ct.</i> - 4.53
		Average of all beef samples .....	-35.42	+4.07	- 9.05	-19.74	- 6.43	-12.66
		Average of all veal samples .....	-34.68	+2.77	- 8.88	+ .40	- 9.26	- 6.31
		Average of all beef and veal samples .....	-35.31	+3.87	- 9.02	-16.64	- 6.87	-11.68

Examination of this table shows that in the case of two pot roasts the average losses expressed as percentages of the several nutrients originally present were: 59.67 per cent water, 40.48 per cent nitrogenous extractives, 50.05 per cent nonnitrogenous extractives, 12.68 per cent fat, and 40.49 per cent ash. There was an apparent gain of 3.91 per cent of proteid.

The average losses in the three roasting experiments were: 24.59 per cent water, 12.47 per cent nitrogenous extractives, 13.92 per cent nonnitrogenous extractives, 6.42 per cent fat, and 7.44 per cent ash. Here again there was an apparent gain in the amount of proteid which amounted to 2.12 per cent.

The losses occurring in the single test in which meat was broiled over a gas flame were as follows: 24.72 per cent water, 3.66 per cent nonnitrogenous extractives, and 6.92 per cent ash. In this experiment there was an apparent gain in the proteid, nitrogenous extractives, and fat amounting to, respectively, 1.58, 1.74, and 29.55 per cent of the total quantity of each of these nutrients in the uncooked meat.

In the four pan-broiling experiments the average losses were: 38.75 per cent water, 0.15 per cent nitrogenous extractives, 6.68 per cent nonnitrogenous extractives, 8.75 per cent fat, and 5.05 per cent ash. There was an apparent gain of 3.87 per cent proteid.

In the two experiments in which the meat was sautéed the average losses were: 22.31 per cent water, 9.48 per cent nonnitrogenous extractives, and 7.03 per cent ash. Again there was an apparent gain of proteid amounting to 5.24 per cent, and also an apparent gain of nitrogenous extractives and fat amounting to 1.44 and 6.57 per cent, respectively.

In the single experiment in which the meat was fried the average losses were: 41.56 per cent water, 2.93 per cent nitrogenous extractives, 25.17 per cent nonnitrogenous extractives, 9.58 per cent fat,



and 4.53 per cent ash. There was an apparent gain of 8.64 per cent proteid.

It is evident from the figures under discussion that a considerable loss in weight results from each of these methods of cooking meats. This is due chiefly to the evaporation of water, but there are also in all instances small losses of total food nutrients. Judging from the limited data here available the losses resulting when meat is cooked as a pot roast are much greater than those which occur in roasting, gas broiling, pan broiling, sautéing, and frying, and the losses which take place when meats are cooked by roasting are apparently greater than those in broiling, sautéing, and frying. The losses noted in connection with the roasting, pan broiling, and sautéing experiments agree in general with those obtained in previous experiments<sup>a</sup> in which meats were cooked by these methods.

In all the roasting, broiling, sautéing, and frying experiments here reported there was an apparent gain of proteid matter during the cooking, and in a few cases there was apparently a small gain of the nitrogenous extractives and also of fat, even where the latter had not been added either before or during the cooking. It is plainly evident that cooking according to these methods could not add nutritive material to the meat except where fat was added in the pot roasting, sautéing, and frying experiments. With the knowledge at present available concerning the nature of the changes resulting in cooking, it is not easy to account for this apparent gain of fat and nitrogenous substances which occurs during the cooking of meats by those methods. This question is being further studied in connection with these investigations.

Attention should be called to the comparatively small losses which take place when meats are cooked by dry heat compared with those which occur when the cooking is done in hot water. The average losses resulting in the 13 experiments in which the meats were cooked by dry heat, expressed in percentages of the total amount of each constituent in the meat, were as follows: 35.31 per cent water, 9.02 per cent nitrogenous extractives, 16.64 per cent nonnitrogenous extractives, 6.87 per cent fat, and 11.68 per cent ash. There was apparently an average gain of 3.87 per cent of proteid.

The average losses occurring in the 31 experiments in which the meat was cooked in hot water, expressed in percentages of the total amount of each constituent of the meat, were as follows: 54.45 per cent water, 3.18 per cent proteid, 71.81 per cent nitrogenous extractives, 72.13 per cent nonnitrogenous extractives, 17.50 per cent fat, and 62.55 per cent ash. It is thus evident that the losses of nutritive constituents which occur in cooking meats in hot water are several times greater than those resulting when meats are cooked by dry heat.

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<sup>a</sup> U. S. Dept. Agr., Office of Experiment Stations Bul. 141.



These differences between the losses occurring when meats are cooked with and without contact with hot water are also plainly noticeable when the results are calculated to the basis of the weight of the uncooked meats. The average losses resulting in the 13 experiments in which the meats were cooked by dry heat thus expressed were: 24.50 per cent water, 0.10 per cent nitrogenous extractives, 0.27 per cent nonnitrogenous extractives, 0.43 per cent fat, and 0.13 per cent ash. The apparent gain of proteid was 0.70 per cent.

The average losses resulting in the 31 boiling experiments, expressed in percentages of the weight of the uncooked meats, were 39.09 per cent water, 0.63 per cent proteid, 0.83 per cent nitrogenous extractives, 1.07 per cent nonnitrogenous extractives, 1.26 per cent fat, and 0.61 per cent ash.

These conclusions are in accord with those on page 140, drawn from the composition of the cold-water extracts of meat cooked in different ways, that cooking meat by dry heat retains more of the nutritive material than cooking it in hot water.

#### A STUDY OF MEAT BROTHS AND SOUPS.

In connection with the nutrition investigations upon meats carried on under the direction of this Office<sup>a</sup> a large amount of unpublished data upon the chemical composition and nutritive value of meats, broths, and soups has been accumulated. Since the available data regarding the composition and true nutritive value of meat broths and soups are as yet quite meager, it has been thought best to present this material in connection with this bulletin. Past investigations have shown in a general way that meat broths and soups contain as a rule only small quantities of true nutritive material, consisting of a portion of the nitrogenous and nonnitrogenous organic extractives (meat bases), proteids, fats, and mineral substances of the meat from which they have been prepared. The true nutritive value of broths is still a disputed question, because a considerable proportion of their solid constituents are composed of the so-called extractives, such as creatin, creatinin, organic acids, glycogen, inosite, and unidentified organic substances and inorganic salts, and the action of these materials upon the animal body is not yet well understood. It seems probable, however, that these extractives have little true nutritive value and that they act chiefly as stimulants to the body or to the process of digestion.

The extended investigations of Pawlow<sup>b</sup> and his associates show that the importance of meat extractives as stimulants to the secretion of normal gastric juice can hardly be overestimated. These bodies

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<sup>a</sup> U. S. Dept. Agr., Office of Experiment Stations Buls. 102 and 141

<sup>b</sup> The Work of the Digestive Glands. London, 1902.

were found to be much more active gastric stimulants than sugar with water or any of the other foods or food accessories tested. It seems apparent, further, that the stimulation of the flow of gastric juice by the specific character of the food eaten is a normal and important part of digestion.

If Pawlow's views are correct, and they are supported by a very large amount of experimental work of a high order, they furnish an explanation of the belief long held by many that soup and broth have a value in dietetics out of proportion to the nutritive material they supply, and, indeed, they offer an explanation of the value of savory foods in general.

In connection with the work here reported it is interesting to summarize the more important investigations of the composition of soup and broth which have been found. For the purpose of studying the composition of broth, König<sup>a</sup> and associates prepared a meat broth from 500 grams of beef and 189 grams of veal bones by the ordinary household method. They obtained 543 cubic centimeters of strong broth or soup, which upon analysis gave the following results: Water, 95.18; total dry substance, 4.82; proteid, 1.19; fat, 1.48; extractives, 1.83, and total nitrogen 0.19 per cent. A. Payen<sup>b</sup> prepared three soups from meat and bones, using as flavoring materials salt, vegetables, and spices. These broths were analyzed with the following average results: Water, 97.73; total dry residue, 1.26; organic matter, 1.31, and salt, 0.96 per cent.

Mrs. Ellen H. Richards and Mrs. Mary H. Abel<sup>c</sup> in 1889 and 1900 prepared and studied the composition of various kinds of broths. The following table gives the results of their analyses:

TABLE 128.—*Composition of broths, beef tea, etc.*

Kind.	Meat.	Total solids.	Solids, juice filtered before coagulation.	Solids, juice filtered after coagulation.	Coagulable albumin.	Extract of meat.	Salts or ash.
Beef juice from meat slightly broiled and pressed (round).....	<i>Per ct.</i> 26.8	<i>Per ct.</i> 11.9	<i>Per ct.</i> 10.8	<i>Per ct.</i> 4.93	<i>Per ct.</i> 6.97	<i>Per ct.</i> 3.90	<i>Per ct.</i> .....
Beef juice from meat slightly broiled and pressed (neck).....	21.9	9.9	9.4	4.72	5.18	3.56	1.36
Beef tea, chopped beef heated in bottle without water.....	26.4	7.91	.....	5.72	2.19	2.09	.....
Beef tea, New England Hospital, with water.....	.....	3.23	.....	2.55	.68	.....	.....
Beef tea, with equal weight of water two hours at 70° C., then boiled two hours.....	.....	.....	.....	.....	.....	2.15	.....
Beef tea, with twice its weight of water two hours at 70° C., then two hours at 85° C.....	.....	.....	.....	.....	.....	2.62	.....
Beef broth, New England kitchen, average of 26 analyses.....	.....	3.53	.....	.....	.....	4.40	.....

<sup>a</sup> *Chemie der Menschlichen Nahrungs- und Genussmittel.* 4. ed., II, p. 1445.

<sup>b</sup> *Substances Alimentaires*, 1865, p. 97.

<sup>c</sup> U. S. Dept. Agr., Office of Experiment Stations Bul. 21, p. 92.

From the work above mentioned it is apparent that the amount of solids in meat broths is generally very small. The analyses of meat broths made by us confirm this conclusion. The following tables summarize the results of the analyses of the broths made in connection with these nutrition investigations since 1898. Table 129 gives the weight of each nutrient actually found by analysis in the clear filtered broths and in the suspended matter in the original broth.

TABLE 129.—*Composition of the clear, filtered broths and the solid matter in the broths.*

Broth from meat, laboratory No.	Experiment No.	Weight of uncooked meat.	Total nutrients in clear broth.						Total nutrients in suspended matter in broth.			
			Proteid.	Organic extractives.			Ash.	Total nutrients.	Proteid.	Fat.	Ash.	Total nutrients.
				Nitrogenous.	Non-nitrogenous.	Total.						
		Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Gm.	Grams.
892...	16	1,220.3	1.273	6.500	7.933	14.493	5.464	21.230	1.111	9.533	.....	10.644
893...	16	1,477.8	2.436	7.375	9.405	16.780	6.140	25.356	1.576	12.623	.....	14.199
771a...	17	705.5	.370	5.505	7.411	12.916	4.044	17.330	1.757	5.586	.....	7.343
771b...	17	660.8	.605	5.010	7.050	12.060	3.875	16.540	1.936	7.606	.....	9.542
894...	18	433.2	.542	3.869	5.088	8.957	3.170	12.669	.382	.958	.....	1.340
895...	18	2,080.6	2.473	15.305	21.025	36.330	12.326	51.129	1.713	2.979	.....	4.692
1027...	19	2,141.3	2.780	18.364	16.056	34.420	11.620	48.820	1.350	10.190	.....	11.540
1097...	19	1,139.5	1.460	7.960	9.600	17.560	5.430	24.450	1.000	2.880	.....	3.880
777a...	20	825.8	2.268	5.568	7.536	13.104	5.016	20.388	.509	6.810	.....	7.319
777b...	20	739.5	2.604	5.624	7.068	12.692	4.576	19.872	.387	6.722	.....	7.109
779a...	21	750.0	2.964	5.480	6.864	12.344	4.832	20.140	.441	8.147	.....	8.588
779b...	21	660.5	2.824	5.256	6.832	12.088	4.432	19.344	.495	4.668	.....	5.163
781a...	22	657.0	2.176	4.416	6.714	11.130	4.010	17.316	.422	5.734	.....	6.156
781b...	22	755.8	2.224	5.652	7.448	13.100	4.760	20.084	.466	3.344	.....	3.810
809a...	23	742.8	1.072	5.376	7.392	12.768	4.576	18.416	.334	8.134	.....	8.468
809b...	23	686.6	.812	5.452	7.612	13.064	4.460	18.336	.277	5.082	.....	5.359
820a...	24	915.1	2.203	4.005	5.507	9.512	3.365	15.080	4.419	1.333	.....	5.752
820b...	24	837.3	3.385	4.750	6.955	11.705	3.920	19.010	5.243	1.652	.....	6.895
823a...	25	798.1	.890	6.215	7.890	14.105	4.605	19.600	2.021	.975	.....	2.996
823b...	25	944.5	1.390	6.940	9.055	15.995	5.185	22.570	1.832	4.846	.....	6.678
1091...	26	1,383.1	1.440	8.246	10.894	19.140	6.320	26.900	.570	11.740	.....	12.310
1092...	26	1,409.6	1.930	7.037	9.133	16.190	5.380	23.500	.440	9.530	.....	9.970
1093...	27	2,120.1	1.680	5.189	7.301	12.490	4.290	18.460	1.670	17.860	.....	19.530
1094...	27	2,193.9	1.090	3.915	7.415	11.330	3.390	15.810	.910	25.910	.....	26.820
1095...	28	1,211.8	1.470	8.913	12.717	21.630	7.460	30.500	.970	20.370	.....	21.340
1096...	28	1,152.6	1.890	8.429	11.561	19.990	6.630	28.510	.590	20.190	.....	20.780
1098...	29	1,017.1	1.990	6.268	10.032	16.300	4.990	23.280	.330	31.710	.....	32.040
1099...	29	1,740.5	2.790	8.766	13.324	22.090	6.830	31.710	2.170	30.750	.....	32.920
1146...	30	713.6	.875	4.910	6.575	11.485	3.623	15.983	.185	4.312	.....	4.497
1147...	30	2,323.1	2.085	12.745	16.905	29.650	10.171	41.906	.632	8.854	.....	9.506
1158...	31	1,380.2	1.060	6.408	9.799	16.207	4.818	22.085	.690	2.579	.....	3.269
1159...	31	1,435.9	.....	.....	.....	.....	9.153	41.150	1.342	14.152	.....	15.494
1160...	32	1,715.9	1.144	3.864	6.009	9.873	2.997	14.014	1.066	89.812	.....	90.878
1161...	32	1,825.8	1.217	5.212	8.095	13.307	3.998	18.522	.615	154.161	.....	154.776
1162...	33	2,393.2	2.470	6.487	9.091	15.578	4.637	22.685	1.178	19.760	.....	20.938
1163...	33	2,729.8	2.825	5.943	8.465	14.408	4.390	21.623	.552	8.471	.....	9.023
1169...	34	1,806.4	2.090	6.374	8.516	14.890	4.490	21.470	.770	51.970	.....	52.740
1170...	34	1,923.6	2.190	5.815	7.295	13.110	4.010	19.310	.450	55.700	.....	56.150
1171...	35	1,523.7	1.260	6.272	8.378	14.650	5.230	21.140	1.290	7.060	.....	8.350
1172...	35	1,765.0	1.220	6.535	9.385	15.920	5.210	22.350	.590	14.750	.....	15.340
1173...	36	1,838.5	1.950	5.058	7.232	12.290	4.000	18.240	.730	8.490	.....	9.220
1174...	36	1,608.5	.980	5.288	7.732	13.020	3.830	17.830	.650	72.810	.....	73.460
1175...	37	1,882.7	.850	6.195	8.045	14.240	4.880	19.970	.210	26.770	.....	26.980
1176...	37	2,016.7	.960	6.914	9.206	16.120	5.550	22.630	.510	38.420	.....	38.930
1177...	38	1,774.2	6.193	7.966	11.191	19.157	6.053	31.403	1.107	13.832	.....	14.939
1178...	38	2,334.7	7.583	9.102	11.652	20.754	7.008	35.345	1.351	2.908	.....	4.259
1179...	39	964.7	1.424	5.923	7.463	13.386	4.045	18.855	.658	79.584	.....	80.242
1180...	39	1,284.2	2.489	7.044	9.982	17.026	4.805	24.320	1.205	68.266	.....	69.471
1181...	40	1,648.3	5.710	7.949	13.291	21.240	6.310	33.260	.910	2.390	.....	3.300
1182...	40	1,939.1	6.670	7.096	10.914	18.010	5.890	30.560	1.500	1.170	.....	2.670
1183...	41	912.8	1.030	4.051	7.949	12.000	3.520	16.540	.300	41.100	.....	41.400
1184...	41	1,268.1	1.750	4.715	9.525	14.240	4.230	20.220	.680	88.140	.....	88.820
1205...	48	1,237.9	.970	6.938	9.159	16.097	5.550	22.610	.650	.750	.....	1.400
1206...	48	1,210.2	1.090	9.595	12.496	22.091	7.210	30.400	.480	.630	.....	1.110
1211...	51	2,141.1	3.090	10.811	12.874	23.685	8.590	35.370	.750	.650	.....	1.400
1212...	51	1,529.9	2.510	10.284	12.586	22.870	8.440	33.820	1.150	4.860	.....	6.010
1242...	54	2,108.6	2.250	8.658	9.902	18.560	7.210	28.020	1.480	1.500	.....	2.980
1243...	54	1,128.0	1.700	6.757	7.380	14.137	5.330	21.170	.840	2.690	.....	3.530
1368...	59	500.0	1.080	4.178	4.905	9.083	3.070	13.240	1.520	.780	.....	2.300
1369...	60	2,500.0	7.670	16.783	17.204	33.987	12.340	53.990	14.430	3.990	.....	18.420

TABLE 129.—Composition of the clear filtered broths and the solid matter in the broths—Continued.

Broth from meat laboratory No	Experiment No	Weight of uncooked meat	Total nutrients in clear broth.						Total nutrients in suspended matter in broth.			
			Pro-teid.	Organic extractives.			Ash.	Total nutrients.	Pro-teid.	Fat.	Ash.	Total nutrients.
				Nitrogenous.	Non-nitrogenous.	Total.						
		Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
1370..	61	500.0	0.990	4.115	5.225	9.340	3.350	13.680	1.720	6.300	.....	8.030
1371..	62	2,500.0	2.580	20.677	24.589	45.266	15.380	63.220	10.600	33.130	.....	43.730
1376..	63	520.8	2.570	2.906	3.336	6.242	2.860	11.670	1.330	.260	.....	1.590
1377..	64	2,384.5	7.800	11.801	13.819	25.620	9.480	42.900	6.690	3.050	.....	9.740
1378..	65	501.4	4.470	3.818	4.104	7.922	3.230	11.620	.210	5.520	.....	5.730
1379..	66	2,502.6	2.720	15.799	20.305	36.104	10.470	49.300	3.960	15.700	.....	19.660
1380..	67	500.0	.880	2.317	1.179	3.496	3.270	7.650	5.110	.970	.....	6.080
1381..	68	2,500.0	9.380	17.688	20.942	38.180	11.800	59.360	11.010	3.660	.....	14.670
1382..	69	500.0	.300	4.718	5.531	10.249	3.210	13.740	.460	4.010	.....	2.470
1383..	70	2,500.0	1.440	21.938	26.290	48.228	15.350	64.920	17.100	22.170	.....	39.280
1384..	71	500.0	2.230	3.439	4.039	7.478	2.430	12.140	2.490	.430	.....	2.920
1385..	72	2,500.0	4.890	10.447	11.670	22.117	7.820	34.830	11.190	4.970	.....	16.170
1386..	73	500.0	.290	3.990	4.851	8.841	3.350	12.490	1.780	3.030	.....	4.810
1387..	74	2,500.0	3.160	14.466	10.305	24.771	9.150	37.090	8.660	4.600	.....	13.260
1639..	107	1,000.0	3.418	8.877	12.501	21.378	6.660	31.455	1.728	7.418	.....	9.146
1641..	108	1,000.0	2.184	10.633	13.590	24.223	7.526	33.933	4.240	6.087	0.040	10.367
1642..	109	1,000.0	1.726	10.214	13.385	23.599	7.725	33.050	13.844	5.935	.008	19.786
1643..	110	1,000.0	4.063	8.759	10.916	19.675	6.375	30.113	2.121	18.476	.....	10.597
1644..	111	1,000.0	2.201	9.162	11.954	21.116	6.994	30.311	3.437	8.501	.....	11.938
1645..	112	1,000.0	1.476	9.903	12.667	22.570	7.235	31.280	6.529	11.421	.....	17.949
1646..	113	1,000.0	2.318	9.177	11.944	21.121	7.381	30.819	6.744	7.090	.....	13.744
1652..	114	1,000.0	5.440	6.683	9.582	16.245	5.080	26.785	1.372	.683	.013	2.068
1653..	115	1,000.0	2.740	8.465	11.305	19.770	6.240	28.750	2.359	.572	.....	2.930
1654..	116	1,000.0	4.046	7.564	11.366	18.930	6.220	29.195	6.077	1.883	.....	7.977
1658..	118	1,000.0	4.528	7.911	9.597	17.508	6.320	28.355	5.694	4.975	.009	10.678
1664..	117	1,000.0	5.001	7.774	9.124	16.898	6.150	28.050	1.356	3.306	.009	4.671
1665..	121	700.0	.....	.....	.....	.....	4.670	20.255	.....	7.115	.024	8.539
1669..	122	1,000.0	6.115	5.611	7.384	12.995	4.355	23.465	.890	64.807	.018	65.715
1673..	123	1,000.0	3.220	6.046	8.549	14.595	4.965	22.780	1.840	63.196	.005	65.041
1703..	125	1,000.0	3.381	8.629	10.274	18.903	5.932	28.216	1.072	23.585	.007	24.663
1704..	126	1,000.0	8.749	7.447	9.400	16.847	5.260	30.856	1.363	30.870	.016	32.250
1707..	127	1,000.0	14.344	1.396	6.612	8.008	1.200	23.552	.270	20.161	.....	20.430
1708..	128	1,000.0	5.596	1.211	3.828	5.039	1.336	11.971	.245	13.436	.....	13.681
1709..	129	1,000.0	.883	.830	1.480	2.310	.564	3.756	.367	75.025	.005	75.997
1710..	130	1,000.0	2.266	1.297	1.692	2.989	1.064	6.320	.219	126.503	.019	126.801
1720..	131	1,000.0	2.873	9.486	13.361	22.847	6.368	32.088	1.369	12.641	.021	14.031
1721..	132	1,000.0	6.014	8.807	12.740	21.547	5.896	33.456	1.038	11.348	.011	12.396
1743..	133	1,000.0	3.500	8.871	11.099	19.970	6.200	29.670	.443	4.565	.016	5.024
1744..	134	1,000.0	2.766	8.778	11.856	20.534	6.120	29.420	.554	3.127	.018	3.699
1745..	135	1,000.0	3.309	8.195	10.656	18.851	5.670	27.830	.980	24.789	.027	25.796
1746..	136	1,000.0	2.130	8.351	10.949	19.300	6.030	27.460	1.324	16.180	.022	17.526
1754..	137	900.0	1.559	7.753	9.506	17.259	5.340	24.159	3.312	7.771	.037	11.120
1755..	138	900.0	2.336	8.007	9.557	17.564	5.680	25.580	2.826	14.536	.020	17.381
1756..	139	900.0	1.536	7.836	9.528	17.364	5.490	24.390	1.334	5.255	.030	6.618
1757..	140	900.0	2.211	8.029	9.749	17.778	5.790	25.689	1.127	5.839	.022	6.988
1772..	145	1,074.8	1.785	8.067	8.957	17.024	5.570	24.380	.852	4.696	.017	5.565
1773..	144	1,027.7	1.497	6.909	7.544	14.453	4.740	20.690	.572	1.752	.012	2.337
1783..	154	1,052.2	1.321	7.702	9.422	17.124	5.520	23.965	1.299	.....	.015	.....
1784..	153	1,098.3	1.777	8.067	9.596	17.663	5.670	25.110	.258	4.182	.003	4.437

## COMPOSITION OF COMPLETE MEAT BROTHS.

Table 130 for the experiments of 1891-1903, and Table 131 for 1903-4 give the composition of the original complete broths. Since the broths varied in consistency, it was necessary to reduce them to a common basis before they could be accurately compared. Each broth was therefore diluted with water until it reached the density at which the amount made from 100 grams of the original meat would weigh 100 grams; or, what is the same thing, the point at which the broth made from 1 pound of meat would measure 1.04 pints. The kind and cut of meat and the method of cooking are indicated in the tables, which hardly need further explanation.



TABLE 130.—*Composition of original complete broth. (Results of experiments made in 1898-1903.)*

[Calculated to the basis, 100 grams of meat give 100 grams of broth, or 1 pound of meat gives 1.04 pints of broth.]

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Amount taken.	Fat in cooked meat.	Method of cooking.		
					Temperature.		Duration of cooking.
					At beginning.	During cooking.	
			<i>Grams.</i>	<i>Per cent.</i>	<i>°C.</i>	<i>°C.</i>	<i>Hours.</i>
1158	31	Beef, round, lean.....	1,380.20	7.10	100	80-85	1½
1095	28	.....do.....	1,211.75	7.27	100	100	2
1096	28	.....do.....	1,152.63	7.95	100	100	2
		Average Nos. 1095 and 1096 ..	1,182.19	7.61	.....	.....	.....
1370	61	Beef, round, lean, ½-inch cubes.....	500.00	14.49	100	80-85	2
1382	69	.....do.....	500.00	12.39	100	80-85	2
		Average.....	500.00	13.44	.....	.....	.....
1371	62	Beef, round, lean, ½-inch cubes.....	2,500.00	12.70	100	80-85	2
1383	70	.....do.....	2,500.00	10.75	100	80-85	2
		Average.....	2,500.00	11.73	.....	.....	.....
		Average Nos. 1370, 1371, 1382, and 1383.....	.....	.....	.....	.....	.....
894	18	Beef, round, lean, small piece.....	433.20	2.70	100	80-85	2
779b	21	.....do.....	660.50	5.87	100	80-85	2
809b	23	.....do.....	686.00	6.34	100	80-85	2
781b	22	.....do.....	755.00	6.50	100	80-85	2
		Average.....	633.68	5.35	.....	.....	.....
1378	65	Beef, round, lean, small piece.....	501.41	7.90	100	80-85	2
779a	21	.....do.....	750.00	8.98	100	80-85	2
1386	73	.....do.....	500.00	8.99	100	80-85	2
809a	23	.....do.....	742.80	9.40	100	80-85	2
781a	22	.....do.....	657.00	10.31	100	80-85	2
777a	20	.....do.....	825.80	10.52	100	80-85	2
777b	20	.....do.....	739.50	11.51	100	80-85	2
		Average.....	673.79	9.66	.....	.....	.....
		Average Nos. 777a, 777b, 779a, 779b, 781a, 781b, 809a, 809b, 894, 1378, and 1386.....	659.20	8.09	.....	.....	.....
1211	51	Beef, round, lean, large piece.....	2,141.09	1.78	100	80-85	2
1205	48	.....do.....	1,237.90	1.97	100	80-85	2
1242	54	.....do.....	2,108.62	3.45	100	80-85	2
895	18	.....do.....	2,080.00	3.64	100	80-85	2
		Average.....	1,891.90	2.71	.....	.....	.....
1379	66	Beef, round, lean, large piece.....	2,500.00	8.56	100	80-85	2
1027	19	.....do.....	2,141.25	8.38	100	80-85	2
1387	74	.....do.....	2,500.00	9.23	100	80-85	2
1097	19	.....do.....	1,139.48	10.53	100	80-85	2
		Average.....	2,070.18	9.18	.....	.....	.....
		Average Nos. 895, 1027, 1097, 1205, 1211, 1242, 1379, and 1387.....	1,984.04	5.95	.....	.....	.....
892	16	Beef, round, fat.....	1,220.30	19.99	100	80-85	2
893	16	.....do.....	1,477.80	18.88	100	80-85	2
1091	26	.....do.....	1,383.07	12.84	100	80-85	2
1092	26	.....do.....	1,409.64	12.67	100	80-85	2
1172	35	.....do.....	1,764.97	15.45	100	80-85	2
		Average.....	1,451.16	15.96	.....	.....	.....
1093	27	Beef, "plate boil," very fat.....	2,120.13	32.32	100	80-85	2
1094	27	.....do.....	2,193.89	35.49	100	80-85	2
		Average.....	2,157.01	33.90	.....	.....	.....
1098	29	Beef, round, rather fat.....	1,017.05	12.54	100	80-85	3
1099	29	.....do.....	1,740.51	18.18	100	80-85	3
1146	30	.....do.....	713.60	7.74	100	80-85	3
1147	30	.....do.....	2,323.10	10.00	100	80-85	3
		Average.....	1,448.56	12.12	.....	.....	.....



TABLE 130.—*Composition of original complete broth. (Results of experiments made in 1898-1903)—Continued.*

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Amount taken.	Fat in cooked meat.	Method of cooking.		
					Temperature.		Duration of cooking.
					At beginning.	During cooking.	
			<i>Grams.</i>	<i>Per cent.</i>	<i>°C.</i>	<i>°C.</i>	<i>Hours.</i>
1160	32	Beef, "plate boil," very fat .....	1,715.90	50.14	100	80-85	3
1161	32	.....do.....	1,825.80	50.73	100	80-85	3
1162	33	Beef, neck, very fat.....	2,393.20	23.62	100	80-85	3
1163	33	.....do.....	2,729.80	29.87	100	80-85	3
1169	34	Beef, ribs, very fat.....	1,806.37	26.04	100	80-85	3
1170	34	.....do.....	1,923.58	34.06	100	80-85	3
		Average of above.....	2,065.77	35.74	.....	.....	.....
1177	38	Veal, leg.....	1,774.20	7.79	100	80-85	3
1178	38	.....do.....	2,334.70	4.18	100	80-85	3
1181	40	.....do.....	1,648.31	5.11	100	80-85	3
1182	40	.....do.....	1,949.09	4.33	100	80-85	3
		Average.....	1,926.58	5.35	.....	.....	.....
1179	39	Mutton, leg.....	964.70	25.50	100	80-85	3
1180	39	.....do.....	1,284.20	18.57	100	80-85	3
1183	41	.....do.....	912.82	14.35	100	80-85	3
1184	41	.....do.....	1,268.14	20.69	100	80-85	3
		Average.....	1,107.46	19.78	.....	.....	.....
1173	36	Pork, fresh ham.....	1,838.40	32.83	100	80-85	3
1174	36	.....do.....	1,608.50	44.66	100	80-85	3
1175	37	.....do.....	1,882.66	36.82	100	80-85	3
1176	37	.....do.....	2,016.70	40.64	100	80-85	3
		Average.....	1,836.56	38.74	.....	.....	.....
1159	31	Beef, round, lean.....	1,435.90	11.18	100	80-85	5
1206	48	.....do.....	1,210.15	1.65	100	80-85	5
1212	51	.....do.....	1,529.94	3.80	100	80-85	5
1243	54	.....do.....	1,128.00	3.69	100	80-85	5
		Average.....	1,326.00	5.08	.....	.....	.....
820a	24	Beef, round, lean.....	915.10	6.11	20-25	50	6
820b	24	.....do.....	837.30	6.58	20-25	50	6
		Average.....	876.20	6.35	.....	.....	.....
1376	63	Beef, round, lean, one piece.....	520.77	2.88	20-25	47-50	5
1384	71	.....do.....	500.00	5.56	20-25	47-50	5
		Average.....	510.38	4.22	.....	.....	.....
1377	64	Beef, round, lean, one piece.....	2,384.54	8.91	20-25	47-50	5
1385	72	.....do.....	2,500.00	11.46	20-25	47-50	5
		Average.....	2,442.27	10.18	.....	.....	.....
1368	59	Beef, round, 1-inch cubes.....	500.00	9.33	20-25	47-50	5
1380	67	.....do.....	500.00	9.50	20-25	47-50	5
		Average.....	500.00	9.42	.....	.....	.....
1369	60	Beef, round, 1/2-inch cubes.....	2,500.00	10.62	20-25	47-50	5
1381	68	.....do.....	2,500.00	8.98	20-25	47-50	5
		Average.....	2,500.00	9.80	.....	.....	.....
		Average Nos. 1368, 1369, 1376, 1377, 1380, 1381, 1384, and 1385.....	.....	8.41	.....	.....	.....
1171	35	Beef, round, lean.....	1,523.68	12.92	20-25	57-60	5
771a	17	.....do.....	705.50	7.23	20-25	80	2 3/4
771b	17	.....do.....	660.80	8.50	20-25	80	2 3/4
823a	25	.....do.....	798.10	6.13	20-25	80	2 3/4
823b	25	.....do.....	944.50	3.47	20-25	80	2 3/4
		Average Nos. 771a, 771b, 823a, and 823b.....	777.22	6.33	.....	.....	.....
		Average of 72 samples.....	1,426.55	.....	.....	.....	.....
		Maximum.....	2,729.80	.....	.....	.....	.....
		Minimum.....	500.00	.....	.....	.....	.....

NOTE.—Experiment No. 31 not included in average.

TABLE 130.—Composition of original complete broth. (Results of experiments made in 1898-1903)—Continued.

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Percentage composition of original complete broth.											
			Water.	Total solid matter.	Proteid.	Organic extractives.				Fat.	Ash.	Nitrogen.		
						Nitrogenous.	Nonnitrogenous.	Total.	Proteid.			Nonproteid.	Total.	
1158	31	Beef, round, lean . . . . .	P. ct. 98.16	P. ct. 1.84	P. ct. 0.13	P. ct. 0.47	P. ct. 0.69	P. ct. 1.16	P. ct. 0.20	P. ct. 0.35	P. ct. 0.021	P. ct. 0.151	P. ct. 0.172	
1095	28	.....do.....	95.72	4.28	.20	.73	1.05	1.78	1.68	.62	.032	.234	.266	
1096	28	.....do.....	95.72	4.28	.22	.73	1.00	1.73	1.75	.58	.035	.234	.269	
		Average Nos. 1095 and 1096 . . . . .	95.72	4.28	.21	.73	1.03	1.76	1.71	.60	.034	.234	.268	
1370	61	Beef, round, lean, ½-inch cubes . . . . .	95.66	4.34	.54	.82	1.05	1.87	1.26	.67	.086	.263	.349	
1382	69	.....do.....	96.36	3.64	.15	.94	1.11	2.05	.80	.64	.024	.301	.325	
		Average . . . . .	96.01	3.99	.35	.88	1.08	1.96	1.03	.66	.055	.282	.337	
1371	62	Beef, round, lean, ½-inch cubes . . . . .	95.72	4.28	.53	.83	.98	1.81	1.33	.61	.085	.266	.351	
1383	70	.....do.....	95.83	4.17	.74	.88	1.05	1.93	.89	.61	.118	.282	.400	
		Average . . . . .	95.78	4.23	.64	.86	1.02	1.87	1.11	.61	.102	.274	.376	
		Average Nos. 1370, 1371, 1382, and 1383 . . . . .	95.89	4.11	.49	.87	1.05	1.91	1.07	.63	.078	.278	.356	
894	18	Beef, round, lean, small piece . . . . .	96.77	3.23	.21	.89	1.17	2.06	.22	.74	.034	.285	.319	
779b	21	.....do.....	96.29	3.71	.50	.80	1.03	1.83	.71	.67	.080	.256	.336	
809b	23	.....do.....	96.55	3.45	.16	.79	1.11	1.90	.74	.65	.026	.253	.279	
781b	22	.....do.....	96.84	3.16	.36	.75	.98	1.73	.44	.63	.058	.240	.298	
		Average . . . . .	96.61	3.39	.31	.81	1.07	1.88	.53	.67	.049	.259	.308	
1378	65	Beef, round, lean, small piece . . . . .	96.54	3.46	.14	.76	.82	1.58	1.10	.64	.022	.243	.265	
779a	21	.....do.....	96.17	3.83	.45	.73	.92	1.65	1.09	.64	.072	.234	.306	
1386	73	.....do.....	96.54	3.46	.41	.80	.97	1.77	.61	.67	.066	.256	.322	
809a	23	.....do.....	96.38	3.62	.19	.72	1.00	1.72	1.09	.62	.030	.231	.261	
781a	22	.....do.....	96.43	3.57	.40	.67	1.02	1.69	.87	.61	.064	.214	.278	
777a	20	.....do.....	96.65	3.35	.34	.67	.91	1.58	.82	.61	.054	.214	.268	
777b	20	.....do.....	96.35	3.65	.40	.76	.96	1.72	.91	.62	.064	.243	.307	
		Average . . . . .	96.44	3.56	.33	.76	.94	1.67	.93	.63	.053	.234	.287	
		Average Nos. 777a, 777b, 779a, 779b, 781a, 781b, 809a, 809b, 894, 1378, and 1386 . . . . .	96.49	3.50	.32	.76	.99	1.75	.78	.65	.052	.243	.294	
1211	51	Beef, round, lean, large piece . . . . .	98.28	1.72	.18	.51	.60	1.11	.03	.40	.029	.163	.192	
1205	48	.....do.....	98.06	1.94	.13	.56	.74	1.30	.06	.45	.021	.179	.200	
1242	54	.....do.....	98.53	1.47	.18	.41	.47	.88	.07	.34	.029	.131	.160	
895	18	.....do.....	97.31	2.69	.21	.74	1.01	1.75	.14	.59	.034	.237	.271	
		Average . . . . .	98.04	1.96	.18	.56	.71	1.26	.08	.45	.028	.178	.206	
1379	66	Beef, round, lean, large piece . . . . .	97.24	2.76	.27	.63	.81	1.44	.63	.42	.043	.202	.245	
1027	19	.....do.....	97.18	2.82	.20	.86	.74	1.60	.48	.54	.032	.276	.308	
1387	74	.....do.....	97.99	2.01	.47	.58	.41	.99	.18	.37	.075	.186	.261	
1097	19	.....do.....	97.51	2.49	.22	.70	.84	1.54	.25	.48	.035	.224	.259	
		Average . . . . .	97.48	2.52	.29	.69	.70	1.39	.39	.45	.046	.222	.268	
		Average Nos. 895, 1027, 1097, 1205, 1211, 1242, 1379, and 1387 . . . . .	97.76	2.24	.23	.63	.70	1.33	.23	.45	.037	.200	.237	

TABLE 130.—Composition of original complete broth. (Results of experiments made in 1898-1903)—Continued.

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Percentage composition of original complete broth.											
			Water.	Total solid matter.	Organic extractives.					Nitrogen.				
					Proteid.	Nitrogenous.		Nonnitrogenous.	Total.	Fat.	Ash.	Proteid.	Nonproteid.	Total.
						P. ct.	P. ct.							
892	16	Beef, round, fat .....	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	
893	16	.....do.....	97.39	2.61	0.20	0.53	0.65	1.18	0.78	0.45	0.032	0.170	0.202	
1091	26	.....do.....	97.32	2.68	.27	.50	.64	1.14	.85	.42	.043	.160	.203	
1092	26	.....do.....	97.16	2.84	.14	.60	.80	1.40	.85	.45	.022	.192	.214	
1092	26	.....do.....	97.63	2.37	.17	.50	.65	1.15	.67	.38	.027	.160	.187	
1172	35	.....do.....	97.86	2.14	.10	.37	.53	.90	.84	.30	.016	.119	.136	
		Average .....	97.47	2.53	.18	.50	.65	1.15	.80	.40	.028	.160	.188	
1093	27	Beef, "plate boil," very fat.....	98.21	1.79	.16	.24	.35	.59	.84	.20	.026	.077	.103	
1094	27	.....do.....	98.06	1.94	.09	.18	.34	.52	1.18	.15	.014	.058	.072	
		Average .....	98.13	1.87	.13	.21	.35	.56	1.01	.18	.020	.068	.088	
1098	29	Beef, round, rather fat.....	94.56	5.44	.23	.62	.98	1.60	3.12	.49	.037	.199	.236	
1099	29	.....do.....	96.29	3.71	.28	.50	.77	1.27	1.77	.39	.045	.160	.205	
1146	30	.....do.....	97.13	2.87	.15	.69	.91	1.60	.62	.50	.024	.221	.245	
1147	30	.....do.....	97.79	2.21	.12	.55	.72	1.27	.39	.43	.019	.176	.195	
		Average .....	96.44	3.56	.20	.59	.85	1.44	1.48	.45	.031	.189	.220	
1160	32	Beef, "plate boil," very fat.....	93.89	6.11	.13	.23	.34	.57	5.24	.17	.021	.074	.095	
1161	32	.....do.....	90.51	9.49	.10	.29	.43	.72	8.45	.22	.016	.093	.109	
1162	33	Beef, neck, very fat.....	98.18	1.82	.15	.26	.39	.65	.83	.19	.024	.083	.107	
1163	33	.....do.....	98.88	1.12	.12	.22	.31	.53	.31	.16	.019	.071	.090	
1169	34	Beef, ribs, very fat.....	95.89	4.11	.16	.35	.47	.82	2.88	.25	.026	.112	.138	
1170	34	.....do.....	96.07	3.93	.14	.30	.38	.68	2.90	.21	.022	.096	.118	
		Average of above.....	95.57	4.43	.13	.28	.39	.66	3.44	.20	.021	.088	.109	
1177	38	Veal, leg.....	97.39	2.61	.41	.45	.63	1.08	.78	.34	.066	.144	.210	
1178	38	.....do.....	98.30	1.70	.38	.39	.50	.89	.13	.30	.061	.125	.186	
1181	40	.....do.....	97.78	2.22	.40	.48	.81	1.29	1.15	.38	.064	.154	.218	
1182	40	.....do.....	98.29	1.71	.42	.37	.56	.93	.06	.30	.067	.119	.186	
		Average .....	97.94	2.06	.40	.42	.63	1.05	.28	.33	.064	.136	.200	
1179	39	Mutton, leg.....	89.73	10.27	.22	.61	.77	1.38	8.25	.42	.035	.196	.231	
1180	39	.....do.....	92.70	7.30	.29	.55	.78	1.33	5.31	.37	.046	.176	.222	
1183	41	.....do.....	93.65	6.35	.15	.44	.87	1.31	4.50	.39	.024	.141	.165	
1184	41	.....do.....	91.40	8.60	.19	.37	.75	1.12	6.95	.34	.030	.119	.149	
		Average .....	91.87	8.13	.21	.49	.79	1.29	6.25	.38	.034	.158	.192	
1173	36	Pork, fresh ham.....	98.50	1.50	.15	.27	.39	.66	.47	.22	.024	.087	.111	
1174	36	.....do.....	94.32	5.68	.10	.33	.48	.81	4.53	.24	.016	.106	.122	
1175	37	.....do.....	97.51	2.49	.05	.33	.43	.76	1.42	.26	.008	.106	.114	
1176	37	.....do.....	96.95	3.05	.07	.34	.46	.80	1.91	.27	.011	.109	.120	
		Average .....	96.82	3.18	.09	.32	.44	.76	2.08	.25	.015	.102	.117	
1159	31	Beef, round, lean.....	96.95						1.00	.63				
1206	48	.....do.....	97.40	2.60	.13	.79	1.03	1.82	.05	.60	.021	.253	.274	
1212	51	.....do.....	97.40	2.60	.24	.67	.82	1.49	.32	.55	.038	.215	.253	
1243	54	.....do.....	97.81	2.19	.23	.60	.65	1.25	.24	.47	.037	.192	.229	
		Average .....	97.39	2.46	.20	.69	.83	1.52	.40	.56	.032	.220	.252	
820a	24	Beef, round, lean.....	97.72	2.28	.72	.44	.60	1.04	.15	.37	.115	.141	.256	
820b	24	.....do.....	96.90	3.10	1.03	.57	.83	1.40	.20	.47	.165	.183	.348	
		Average .....	97.31	2.69	.88	.51	.72	1.22	.18	.42	.140	.162	.302	
1376	63	Beef, round, lean, one piece.....	97.45	2.55	.75	.56	.64	1.20	.05	.55	.120	.179	.299	
1384	71	.....do.....	96.99	3.01	.94	.69	.80	1.49	.09	.49	.150	.221	.371	
		Average .....	97.22	2.78	.85	.63	.72	1.35	.07	.52	.135	.200	.335	

TABLE 130.—Composition of original complete broth. (Results of experiments made in 1898-1903)—Continued.

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Percentage composition of original complete broth.											
			Water.	Total solid matter.	Proteid.	Organic extractives.				Fat.	Ash.	Nitrogen.		
						Nitrogenous.	Nonnitrogenous.	Total.	Proteid.			Nonproteid.	Total.	
1377	64	Beef, round, lean, one piece.....	<i>P. ct.</i> 97.79	<i>P. ct.</i> 2.21	<i>P. ct.</i> 0.61	<i>P. ct.</i> 0.50	<i>P. ct.</i> 0.58	<i>P. ct.</i> 1.08	<i>P. ct.</i> 0.13	<i>P. ct.</i> 0.39	<i>P. ct.</i> 0.098	<i>P. ct.</i> 0.160	<i>P. ct.</i> 0.258	
1385	72	.....do.....	97.96	2.04	.64	.42	.47	.89	.20	.31	.102	.135	.237	
		Average.....	97.87	2.13	.63	.46	.53	.99	.17	.35	.100	.148	.248	
1368	59	Beef, round, ½-inch cubes.....	96.89	3.11	.52	.84	.98	1.82	.16	.61	.083	.269	.352	
1380	67	.....do.....	97.25	2.75	1.20	.46	.24	.70	.19	.66	.192	.147	.339	
		Average.....	97.07	2.93	.86	.65	.61	1.26	.18	.64	.138	2.08	.346	
1369	60	Beef, round, ½-inch cubes.....	97.10	2.90	.88	.67	.69	1.36	.16	.50	.141	.215	.356	
1381	68	.....do.....	97.04	2.96	.82	.70	.82	1.32	.15	.47	.131	.224	.355	
		Average.....	97.07	2.93	.85	.69	.76	1.44	.16	.49	.136	.220	.356	
		AverageNos.1368, 1369, 1376, 1377, 1380, 1381, 1384, and 1385.....	97.31	2.69	.80	.61	.65	1.26	.14	.50	.127	.194	.321	
1171	35	Beef, round, lean.....	98.06	1.94	.17	.41	.55	.96	.46	.35	.027	.131	.158	
771a	17	.....do.....	96.50	3.50	.30	.78	1.05	1.83	.80	.57	.048	.250	.298	
771b	17	.....do.....	96.05	3.95	.38	.76	1.07	1.83	1.15	.59	.061	.244	.305	
823a	25	.....do.....	97.17	2.83	.36	.78	.99	1.77	.12	.58	.058	.250	.308	
823b	25	.....do.....	96.90	3.10	.34	.74	.96	1.70	.51	.55	.054	.237	.291	
		AverageNos.771a, 771b, 823a, and 823b.....	96.65	3.35	.35	.77	1.02	1.78	.65	.57	.055	.245	.300	
		Average of 72 samples.....	96.64	3.36	.33	.58	.74	1.32	1.25	.45	.052	.186	.237	
		Maximum.....	98.88	10.27	1.20	.94	1.17	2.06	8.45	.74	1.92	.285	.375	
		Minimum.....	89.73	1.12	.05	.18	.24	.52	.03	.15	.011	.058	.072	

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Composition of complete broth. (Water-free substance).					
			Proteid	Organic extractives.			Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.	Total.		
1158	31	Beef, round, lean.....	<i>Per ct.</i> 7.07	<i>Per ct.</i> 25.54	<i>Per ct.</i> 37.50	<i>Per ct.</i> 63.04	<i>Per ct.</i> 10.87	<i>Per ct.</i> 19.01
1095	28	.....do.....	4.67	17.06	24.53	41.59	39.25	14.49
1096	28	.....do.....	5.14	17.06	23.36	40.42	40.89	13.55
		Average Nos. 1095 and 1096.....	4.91	17.06	23.95	41.01	40.07	14.02
1370	61	Beef, round, lean, ½-inch cubes.....	12.44	18.89	24.20	43.09	29.03	15.44
1382	69	.....do.....	4.12	25.82	30.49	56.32	21.98	17.58
		Average.....	8.28	22.36	27.35	49.71	25.51	16.51
1371	62	Beef, round lean, ½-inch cubes.....	12.38	19.39	22.90	42.29	31.07	14.25
1383	70	.....do.....	17.75	21.10	25.18	46.28	21.35	14.63
		Average.....	15.07	20.25	24.04	44.29	26.21	14.44
		Average Nos. 1370, 1371, 1382, and 1383.....	11.67	21.30	25.69	46.99	25.86	15.48



TABLE 130.—Composition of original complete broth. (Results of experiments made in 1898–1903)—Continued.

Lab- ora- tory No.	Cook- ing ex- per- iment No.	Kind of meat used for cooking.	Composition of complete broth. (Water-free substance.)					
			Pro- teid.	Organic extractives.			Fat.	Ash.
				Nitrog- enous.	Non- nitrog- enous.	Total.		
894	18	Beef, round, lean, small piece . . . . .	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
779b	21	do. . . . .	6.50	27.55	36.22	63.78	6.81	22.91
809b	23	do. . . . .	13.48	21.56	27.76	49.33	19.14	18.06
781b	22	do. . . . .	4.64	22.90	32.17	55.07	21.45	18.84
		do. . . . .	11.39	23.73	31.01	54.74	13.92	19.94
		Average . . . . .	9.00	23.94	31.79	55.73	15.33	19.94
1378	65	Beef, round, lean, small piece . . . . .	4.05	21.97	23.70	45.67	31.79	18.50
779a	21	do. . . . .	11.75	19.06	24.02	43.08	28.43	16.71
1386	73	do. . . . .	11.85	23.13	28.03	51.16	17.63	19.34
809a	23	do. . . . .	5.25	19.89	27.62	47.51	30.11	17.13
781a	22	do. . . . .	11.20	18.77	28.57	47.34	24.37	17.09
777a	20	do. . . . .	10.15	20.00	27.16	47.16	24.48	18.21
777b	20	do. . . . .	10.96	20.82	26.30	47.12	24.93	16.99
		Average . . . . .	9.32	20.52	26.49	47.01	25.96	17.71
		Average Nos. 777a, 777b, 779a, 779b, 781a, 781b, 809a, 809b, 894, 1378, and 1386 . . . . .	9.20	21.76	28.42	50.18	22.10	18.52
1211	51	Beef, round, lean, large piece . . . . .	10.46	29.65	34.88	64.53	1.74	23.26
1205	48	do. . . . .	6.70	28.87	38.14	67.01	3.09	23.20
1242	54	do. . . . .	12.24	27.82	31.97	59.79	4.76	23.14
895	18	do. . . . .	7.81	27.51	37.55	65.06	5.20	21.93
		Average . . . . .	9.30	28.46	35.63	64.10	3.70	22.88
1379	66	Beef, round, lean, large piece . . . . .	9.78	22.83	29.35	52.18	22.83	15.22
1027	19	do. . . . .	7.09	30.50	26.24	56.74	17.02	19.15
1387	74	do. . . . .	23.38	28.86	20.40	49.26	8.96	18.41
1097	19	do. . . . .	8.84	28.11	33.73	61.84	10.04	19.28
		Average . . . . .	12.27	27.58	27.43	55.01	14.71	18.02
		Average Nos. 895, 1027, 1097, 1205, 1211, 1242, 1379, and 1387 . . . . .	10.79	28.02	31.53	59.55	9.21	20.45
892	16	Beef, round, fat . . . . .	7.66	20.31	24.90	45.21	29.89	17.24
893	16	do. . . . .	10.07	18.66	23.88	42.54	31.72	15.67
1091	26	do. . . . .	4.93	21.13	28.17	49.30	29.97	15.85
1092	26	do. . . . .	7.17	21.10	27.42	48.52	28.27	16.03
1172	35	do. . . . .	4.67	17.29	24.77	42.06	39.25	14.02
		Average . . . . .	6.90	19.70	25.83	45.53	31.62	15.76
1093	27	Beef, "plate boil," very fat . . . . .	8.94	13.41	19.55	32.96	46.93	11.17
1094	27	do. . . . .	4.64	9.28	17.53	26.81	60.84	7.73
		Average . . . . .	6.79	11.35	18.54	29.89	53.89	9.45
1098	29	Beef, round, rather fat . . . . .	4.23	11.38	18.02	29.41	57.35	9.01
1099	29	do. . . . .	7.55	13.48	20.75	34.23	47.71	10.51
1146	30	do. . . . .	5.23	24.04	31.71	55.75	21.60	17.42
1147	30	do. . . . .	5.43	24.89	32.58	57.46	17.65	19.46
		Average . . . . .	5.61	18.45	25.77	44.21	36.08	14.10
1160	32	Beef, "plate boil," very fat . . . . .	2.13	3.76	5.56	9.33	85.76	2.78
1161	32	do. . . . .	1.05	3.06	4.53	7.59	89.04	2.32
1162	33	Beef, neck, very fat . . . . .	8.24	14.29	21.43	35.72	45.60	10.44
1163	33	do. . . . .	10.71	10.64	27.68	47.32	27.68	14.28
1169	34	Beef, ribs, very fat . . . . .	3.89	8.52	11.44	19.95	70.07	6.09
1170	34	do. . . . .	3.56	7.63	9.67	17.30	73.79	5.35
		Average of above . . . . .	4.93	9.48	13.39	22.87	65.32	6.88
1177	38	Veal, leg . . . . .	15.71	17.24	24.14	41.38	29.88	13.03
1178	38	do. . . . .	22.35	22.94	29.41	52.35	7.65	17.65
1181	40	do. . . . .	18.02	21.62	36.49	58.11	6.76	17.12
1182	40	do. . . . .	24.56	21.64	32.75	54.39	3.51	17.54
		Average . . . . .	20.16	20.86	30.70	51.56	11.95	16.34



TABLE 130.—Composition of original complete broth. (Results of experiments made in 1898-1903)—Continued.

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Composition of complete broth. (Water-free substance.)					
			Proteid.	Organic extractives.			Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.	Total.		
			<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1179	39	Mutton, leg.....	2.14	5.94	7.50	13.44	80.33	4.09
1180	39	.....do.....	3.97	7.53	10.69	18.22	72.74	5.07
1183	41	.....do.....	2.36	6.93	13.70	20.63	70.87	6.14
1184	41	.....do.....	2.21	4.30	8.72	13.02	80.81	3.95
		Average.....	2.67	6.18	10.15	16.33	76.19	4.81
1173	36	Pork, fresh ham.....	10.00	18.00	26.00	44.00	31.33	14.67
1174	36	.....do.....	1.76	5.81	8.45	14.26	79.75	4.23
1175	37	.....do.....	2.01	13.25	17.27	30.52	57.03	10.44
1176	37	.....do.....	2.30	11.15	15.08	26.23	62.62	8.85
		Average.....	4.02	12.05	16.70	28.75	57.68	9.55
1159	31	Beef, round, lean.....	5.00	30.39	39.62	70.00	1.92	23.08
1206	48	.....do.....	9.23	25.77	31.54	57.31	12.31	21.15
1212	51	.....do.....	10.50	27.40	29.68	57.08	10.96	21.46
1243	54	.....do.....	8.24	27.85	33.61	61.46	8.40	21.90
		Average.....	8.24	27.85	33.61	61.46	8.40	21.90
820a	24	Beef, round, lean.....	31.58	19.30	26.31	45.61	6.58	16.23
820b	24	.....do.....	33.23	18.39	26.78	45.16	6.45	15.16
		Average.....	32.41	18.85	26.55	45.39	6.52	15.70
1376	63	Beef, round, lean, one piece.....	29.41	21.96	25.10	47.06	1.96	21.57
1384	71	.....do.....	32.23	22.92	26.58	49.50	2.99	16.28
		Average.....	30.82	22.44	25.84	48.28	2.48	18.93
1377	64	Beef, round, lean, one piece.....	27.60	22.62	26.24	48.87	5.88	17.65
1385	72	.....do.....	31.37	20.59	23.04	43.63	9.80	15.20
		Average.....	29.49	21.61	24.64	46.25	7.84	16.43
1368	59	Beef, round, ½-inch cubes.....	16.72	27.01	31.51	58.52	5.15	19.61
1380	67	.....do.....	43.64	16.73	8.73	25.45	6.91	24.00
		Average.....	30.18	21.87	20.12	41.99	6.03	21.81
1369	60	Beef, round, ½-inch cubes.....	30.34	23.10	23.79	46.90	5.52	17.24
1381	68	.....do.....	27.70	23.65	27.70	51.35	5.07	15.88
		Average.....	29.02	23.38	25.75	49.13	5.30	16.56
		Average Nos. 1368, 1369 1376, 1377, 1380, 1381, 1384, and 1385.....	29.85	22.32	24.09	46.41	5.41	18.43
1171	35	Beef, round, lean.....	8.74	21.13	28.33	49.46	23.76	18.04
771a	17	.....do.....	8.57	22.29	30.00	52.29	22.86	16.29
771b	17	.....do.....	9.62	19.24	27.09	46.33	29.11	14.94
823a	25	.....do.....	12.72	27.56	34.98	62.54	4.24	20.50
823b	25	.....do.....	10.97	23.87	30.97	54.84	16.45	17.74
		Average Nos. 771a, 771b, 823a, and 823b.....	10.47	23.24	30.76	54.00	18.17	17.37
		Average of 73 samples.....	11.54	19.51	24.91	44.42	28.68	15.38
		Maximum.....	43.64	30.50	39.62	70.00	89.04	24.00
		Minimum.....	1.05	3.06	4.53	7.59	1.74	2.32

NOTE.—Experiment No. 31 not included in average.

TABLE 131.—*Composition of original complete broth. (Results of experiments made in 1903-1904.)*

[Calculated to the basis, 100 grams of meat give 100 grams of broth, or 1 pound of meat gives 1.04 pints of broth.]

Lab- ora- tory No.	Cook- ing ex- per- iment No.	Kind of meat used for cooking.	Amount taken.	Fat in cooked meat.	Method of cooking.		
					Temperature.		Duration of cook- ing.
					At be- ginning.	During cooking	
			<i>Grams.</i>	<i>Per cent</i>	<i>°C.</i>	<i>°C.</i>	<i>Hours.</i>
1642	109	Beef, round, 1-inch cubes.....	1,000	3.93	Cold.	85	3
1754	137	Beef, round, 2-inch cubes.....	900	6.80	Cold.	85	3
		Average.....		5.37	Cold.	85	3
1756	139	Beef, round, browned, 2-inch cubes.....	900	8.00	Cold.	85	3
		Average Nos. 1642, 1754, and 1756.....		6.24	Cold.	85	3
1746	136	Beef, round, browned, 2-inch cubes.....	1,000	7.12	85	85	3
1769	145	Beef, round, 2-inch cubes.....	1,074.83	6.87	85	85	3
1780	154	.....do.....	1,052.17	6.62	85	85	3
		Average.....		6.75	85	85	3
		Average Nos. 1746, 1769, and 1780.....		6.87	85	85	3
1641	108	Beef, round, 1-inch cubes.....	1,000	4.38	100	85	3
1744	134	Beef, round, 2-inch cubes.....	1,000	4.83	100	85	3
		Average.....		4.61	100	85	3
1768	144	Beef, round, 1 piece.....	1,027.72	7.51	100	85	3
1779	153	.....do.....	1,098.31	7.88	100	85	3
		Average.....		7.70	100	85	3
		Average Nos. 1641, 1744, 1768, and 1779.....		6.15	100	85	3
1755	138	Beef, round, 2-inch cubes.....	900	7.35	Cold.	100	3
1757	140	Beef, round, browned, 2-inch cubes.....	900	6.83	Cold.	100	3
		Average.....		7.09	Cold.	100	3
1743	133	Beef, round, 2-inch cubes.....	1,000	5.06	100	100	3
1745	135	Beef, round, browned, 2-inch cubes.....	1,000	7.74	100	100	3
		Average.....		6.40	100	100	3
		Average of all cooked 3 hours.....		6.49			3
1646	113	Beef, round, ¾-inch cubes.....	1,000	5.57	Cold.	65	5
1645	112	Beef, round, ¾-inch cubes.....	1,000	5.23	Cold.	85	5
1654	116	Veal, leg, 1-inch cubes.....	1,000	.97	Cold.	85	5
1658	118	.....do.....	1,000	5.58	Cold.	85	5
		Average Nos. 1654 and 1658.....		3.28	Cold.	85	5
		Average Nos. 1645, 1654, and 1658.....		3.93	Cold.	85	5
1644	111	Beef, round, ¾-inch cubes.....	1,000	5.75	100	85	5
1720	131	Beef, round, 1-inch cubes.....	1,000	11.61	100	85	5
		Average.....		8.68	100	85	5
1665	121	Beef, neck, ¾-inch cubes.....	700	13.68	100	85	5
1673	123	Beef, rump, 1-inch cubes.....	1,000	42.03	100	85	5
1703	125	.....do.....	1,000	23.36	100	85	5
		Average.....		32.70	100	85	5
1669	122	Beef, flank, fat ¾-inch cubes.....	1,000	34.16	100	85	5
1653	115	Veal, leg, 1-inch cubes.....	1,000	1.31	100	85	5
1664	117	.....do.....	1,000	7.77	100	85	5
		Average.....		4.54	100	85	5
		Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....		17.46	100	85	5

TABLE 131.—*Composition of original complete broth. (Results of experiments made in 1903-1904)*—Continued.

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Amount taken.	Fat in cooked meat.	Method of cooking.		
					Temperature.		Duration of cooking.
					At beginning.	During cooking.	
			<i>Grams.</i>	<i>Per cent.</i>	<i>°C.</i>	<i>°C.</i>	<i>Hours.</i>
1639	107	Beef, round, 1-inch cubes.....	1,000	.....	100	100	5
1643	110	Beef, round, 2-inch cubes.....	1,000	5.66	100	100	5
1721	132	Beef, round, 1-inch cubes.....	1,000	9.01	100	100	5
		Average.....	.....	7.34	100	100	5
1704	126	Beef, rump, 1-inch cubes.....	1,000	16.07	100	100	5
1652	114	Veal, leg, 1-inch cubes.....	1,000	1.59	100	100	5
		Average Nos. 1639, 1643, 1652, 1704, and 1721.....	.....	8.08	100	100	5
		Average of all cooked 5 hours.....	.....	11.83	.....	.....	5
		Average of all cooked 3 and 5 hours.....	.....	9.34	.....	.....	.....
		Maximum.....	1,098.31	42.03	.....	.....	.....
		Minimum.....	700.00	.97	.....	.....	.....

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Percentage composition of original complete broth.										
			Water.	Total solid matter.	Proteid.	Organic extractives.			Fat.	Ash.	Nitrogen.		
						Nitrogenous.	Nonnitrogenous.	Total.			Proteid.	Nonproteid.	Total.
1642	109	Beef, round, 1-inch cubes.....	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
1754	137	Beef, round, 2-inch cubes.....	94.716	5.284	1.557	1.021	1.339	2.360	0.594	0.773	0.249	0.327	0.576
		Average.....	96.080	3.920	.541	.862	1.056	1.918	.863	.598	.087	.276	.363
1756	139	Beef, round, browned, 2-inch cubes.....	95.398	4.602	1.049	.942	1.198	2.139	.729	.686	.168	.302	.470
		Average Nos. 1642, 1754, and 1756.....	96.555	3.445	.319	.871	1.059	1.930	.584	.613	.051	.279	.330
1746	136	Beef, round, browned, 2-inch cubes.....	95.784	4.216	.806	.918	1.151	2.069	.680	.661	.129	.294	.423
1769	145	Beef, round, 2-inch cubes.....	95.501	4.499	.345	.835	1.095	1.930	1.618	.605	.055	.268	.323
1780	154	.....do.....	97.214	2.786	.245	.751	.833	1.584	.437	.520	.039	.241	.280
		Average.....	97.214	2.786	.249	.732	.896	1.628	.....	.526	.040	.234	.274
		Average Nos. 1746, 1769, and 1780.....	97.214	2.786	.247	.742	.865	1.606	.437	.523	.040	.238	.277
1641	108	Beef, round, 1-inch cubes.....	96.358	3.643	.280	.773	.941	1.714	1.028	.550	.045	.248	.292
1744	134	Beef, round, 2-inch cubes.....	95.570	4.430	.642	1.063	1.359	2.422	.609	.757	.103	.341	.444
		Average.....	96.688	3.312	.332	.868	1.186	2.054	.313	.614	.053	.278	.331
1768	144	Beef, round, 1 piece.....	96.129	3.871	.487	.966	1.273	2.238	.461	.686	.078	.310	.388
1779	153	.....do.....	97.759	2.241	.201	.672	.734	1.406	.171	.462	.032	.216	.248
		Average.....	97.275	2.725	.185	.735	.874	1.609	.415	.516	.030	.265	.295
		Average Nos. 1641, 1744, 1768, and 1779.....	97.517	2.483	.193	.704	.804	1.508	.293	.489	.031	.241	.272
		Average Nos. 1641, 1744, 1768, and 1779.....	96.823	3.177	.340	.835	1.038	1.873	.377	.587	.055	.275	.330

TABLE 131.—Composition of original complete broth. (Results of experiments made in 1903-1904)—Continued.

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Percentage composition of original complete broth.											
			Water.	Total solid matter.	Organic extrac- tives.					Nitrogen.				
					Proteid.	N itro- ge- nous.	Nonnitro- genous.	Total.	Fat.	Ash.	Proteid.	Nonproteid.	Total.	
1755	138	Beef, round, 2-inch cubes.....	P. ct. 95.227	P. ct. 4.773	P. ct. 0.574	P. ct. 0.890	P. ct. 1.062	P. ct. 1.952	P. ct. 1.615	P. ct. 0.633	P. ct. 0.092	P. ct. 0.285	P. ct. 0.377	
1757	140	Beef, round, browned, 2-inch cubes.....	96.369	3.631	.371	.892	1.083	1.975	.649	.636	.059	.286	.345	
		Average.....	95.798	4.202	.473	.891	1.073	1.964	1.132	.635	.076	.286	.361	
1743	133	Beef, round, 2-inch cubes.....	96.531	3.469	.394	.887	1.110	1.997	.457	.622	.063	.284	.347	
1745	135	Beef, round, browned, 2-inch cubes.....	94.637	5.363	.429	.820	1.066	1.886	2.479	.570	.069	.262	.331	
		Average.....	95.584	4.416	.412	.854	1.088	1.942	1.468	.596	.066	.273	.339	
		Average of all cooked 3 hours....	96.163	3.837	.456	.850	1.054	1.904	.877	.603	.073	.274	.348	
1646	113	Beef, round, 1/2-inch cubes.....	95.544	4.456	.906	.918	1.194	2.112	.700	.738	.145	.294	.439	
1645	112	Beef, round, 1/2-inch cubes.....	95.077	4.923	.801	.990	1.267	2.257	1.142	.724	.128	.318	.446	
1654	116	Veal, leg, 1-inch cubes.....	96.283	3.717	1.012	.756	1.137	1.893	.188	.624	.162	.242	.404	
1658	118	.....do.....	96.097	3.903	1.022	.791	.960	1.751	.498	.633	.164	.253	.417	
		Average Nos. 1654 and 1658.....	96.190	3.810	1.017	.774	1.049	1.822	.343	.629	.163	.248	.411	
		Average Nos. 1645, 1654, and 1658.....	95.819	4.181	.945	.846	1.121	1.967	.609	.660	.151	.271	.422	
1644	111	Beef, round, 1/2-inch cubes.....	95.775	4.225	.564	.916	1.195	2.111	.850	.699	.090	.294	.384	
1720	131	Beef, round, 1-inch cubes.....	95.388	4.612	.424	.949	1.336	2.285	1.264	.639	.068	.304	.372	
		Average.....	95.582	4.419	.494	.933	1.266	2.198	1.057	.669	.079	.299	.378	
1665	121	Beef, neck, 1/2-inch cubes.....							1.017	.671			.335	
1673	123	Beef, rump, 1-inch cubes.....	91.218	8.782	.506	.605	.855	1.460	6.320	.497	.081	.194	.275	
1703	125	.....do.....	94.712	5.288	.445	.863	1.027	1.890	2.359	.594	.071	.277	.348	
		Average.....	92.965	7.035	.476	.734	.941	1.675	4.340	.546	.076	.236	.312	
1669	122	Beef, flank, fat, 1/2-inch cubes.....	91.082	8.918	.701	.561	.738	1.299	6.481	.437	.112	.180	.292	
1653	115	Veal, leg, 1-inch cubes.....	96.832	3.168	.510	.847	1.131	1.978	.057	.624	.082	.272	.354	
1664	117	.....do.....	96.728	3.272	.636	.777	.912	1.689	.331	.616	.102	.249	.351	
		Average.....	96.780	3.220	.573	.812	1.022	1.834	.194	.620	.092	.261	.353	
		Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	94.534	5.466	.541	.788	1.028	1.816	2.335	.597	.087	.253	.339	
1639	107	Beef, round, 1-inch cubes.....	95.940	4.060	.515	.888	1.250	2.138	.742	.666	.082	.285	.367	
1643	110	Beef, round, 1/2-inch cubes.....	95.929	4.071	.618	.876	1.092	1.968	.848	.638	.099	.280	.379	
1721	132	Beef, round, 1-inch cubes.....	95.415	4.585	.705	.881	1.274	2.155	1.135	.591	.113	.282	.395	
		Average.....	95.761	4.239	.613	.882	1.205	2.087	.908	.632	.098	.282	.380	

TABLE 131.—*Composition of original complete broth. (Results of experiments made in 1903-1904)*—Continued.

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Percentage composition of original complete broth.										
			Water.	Total solid matter.	Proteid.	Organic extractives.			Fat.	Ash.	Nitrogen.		
						Nitrogenous.	Nonnitrogenous.	Total.			Proteid.	Nonproteid.	Total.
1704	126	Beef, rump, 1-inch cubes.....	<i>P. ct.</i> 93.689	<i>P. ct.</i> 6.311	<i>P. ct.</i> 1.011	<i>P. ct.</i> 0.745	<i>P. ct.</i> 0.940	<i>P. ct.</i> 1.685	<i>P. ct.</i> 3.087	<i>P. ct.</i> 0.528	<i>P. ct.</i> 0.162	<i>P. ct.</i> 0.239	<i>P. ct.</i> 0.401
1652	114	Veal, leg, 1-inch cubes.....	97.115	2.885	.681	.668	.958	1.626	.068	.509	.109	.214	.323
		Average Nos. 1639, 1643, 1652, 1704, and 1721.....	95.617	4.383	0.706	0.812	1.103	1.914	1.176	0.586	0.113	0.260	0.373
		Average of all cooked 5 hours....	95.177	4.823	.691	.814	1.079	1.893	1.593	.613	.111	.261	.370
		Average of all cooked 3 and 5 hours.....	95.619	4.381	.581	.831	1.067	1.898	1.263	.609	.093	.267	.360
		Maximum.....	97.759	8.918	1.557	1.063	1.359	2.422	6.481	.773	.249	.341	.576
		Minimum.....	91.082	2.241	.185	.561	.734	1.299	.057	.437	.030	.180	.248

Laboratory No.	Cooking experiment No.	Kind of meat used for cooking.	Composition of water-free substance of entire complete broth.					
			Proteid.	Organic extractives.			Fat.	Ash.
				Nitrogenous.	Non-nitrogenous.	Total.		
1642	109	Beef, round, 1-inch cubes.....	<i>Per ct.</i> 29.47	<i>Per ct.</i> 19.32	<i>Per ct.</i> 25.34	<i>Per ct.</i> 44.66	<i>Per ct.</i> 11.24	<i>Per ct.</i> 14.63
1754	137	Beef, round, 2-inch cubes.....	13.80	21.99	26.94	48.93	22.02	15.25
		Average.....	21.64	20.66	26.14	46.80	16.63	14.94
1756	139	Beef, round, browned, 2-inch cubes..	9.26	25.28	30.74	56.02	16.95	17.79
		Average Nos. 1642, 1754, and 1756.....	17.51	22.20	27.67	49.87	16.74	15.89
1746	136	Beef, round, browned, 2-inch cubes..	7.67	18.56	24.34	42.90	35.96	13.45
1769	145	Beef, round, 2-inch cubes.....	8.79	26.96	29.90	56.86	15.69	18.66
1780	154	.....do.....						
		Average.....						
		Average Nos. 1746, 1769, and 1780.....	8.23	22.76	27.12	49.88	25.83	16.06
1641	108	Beef, round, 1-inch cubes.....	14.49	24.00	30.68	54.67	13.75	17.09
1744	134	Beef, round, 2-inch cubes.....	10.02	26.20	35.81	62.01	9.45	18.54
		Average.....	12.26	25.10	33.25	58.34	11.60	17.82
1768	144	Beef, round, 1 piece.....	8.97	29.99	32.75	62.74	7.63	20.62
1779	153	.....do.....	6.79	26.97	32.07	59.04	15.23	18.94
		Average.....	7.88	28.48	32.41	60.89	11.43	19.78
		Average Nos. 1641, 1744, 1768, and 1779.....	10.07	26.79	32.83	59.62	11.52	18.80
1755	138	Beef, round, 2-inch cubes.....	12.03	18.65	22.25	40.90	33.84	13.26
1757	140	Beef, round, browned, 2-inch cubes..	10.22	24.57	29.83	54.40	17.87	17.52
		Average.....	11.13	21.61	26.04	47.65	25.86	15.39



TABLE 131.—*Composition of original complete broth. (Results of experiments made in 1903-1904)*—Continued.

Lab- ora- tory No.	Cook- ing ex- peri- ment No.	Kind of meat used for cooking.	Composition of water-free substance of entire complete broth.					
			Organic extractive.				Fat.	Ash.
			Pro- teid.	Nitrog- enous.	Non- nitrog- enous.	Total.		
1743	133	Beef, round, 2-inch cubes.....	<i>Per ct.</i> 11.36	<i>Per ct.</i> 25.57	<i>Per ct.</i> 32.00	<i>Per ct.</i> 57.57	<i>Per ct.</i> 13.17	<i>Per ct.</i> 17.93
1745	135	Beef, round, browned, 2-inch cubes..	8.00	15.29	19.88	35.17	46.22	10.63
		Average.....	9.68	20.43	25.94	46.37	29.70	14.28
		Average of all cooked 3 hours..	11.61	23.34	28.66	51.99	19.92	16.49
1646	113	Beef, round, 3-inch cubes.....	20.33	20.60	26.80	47.40	15.71	16.56
1645	112	Beef, round, 3-inch cubes.....	16.27	20.11	25.74	45.85	23.20	14.76
1654	116	Veal, leg, 1-inch cubes.....	27.25	20.34	30.59	50.93	5.06	16.79
1658	118	do.....	26.18	20.27	24.60	44.86	12.75	16.22
		Average Nos. 1654 and 1658.....	26.72	20.31	27.60	47.90	8.91	16.51
		Average, Nos. 1645, 1654, and 1658.....	23.23	20.24	26.98	47.21	13.67	15.92
1644	111	Beef, round, 3-inch cubes.....	13.35	21.68	28.28	49.96	20.12	16.54
1720	131	Beef, round, 1-inch cubes.....	9.19	20.58	28.96	49.54	27.41	13.79
		Average.....	11.27	21.13	28.62	49.75	23.77	15.17
1665	121	Beef, neck, 3-inch cubes.....						
1673	123	Beef, rump, 1-inch cubes.....	5.76	6.89	9.74	16.63	71.97	5.66
1703	125	do.....	8.42	16.32	19.42	35.74	44.61	11.23
		Average.....	7.09	11.61	14.58	26.19	58.29	8.45
1669	122	Beef, flank, fat, 3-inch cubes.....	7.86	6.29	8.28	14.57	72.67	4.90
1653	115	Veal, leg, 1-inch cubes.....	16.10	26.74	35.70	62.44	1.80	19.70
1664	117	do.....	19.44	23.75	27.87	51.62	10.12	18.83
		Average.....	17.77	25.25	31.70	57.03	5.96	19.27
		Average Nos. 1644, 1654, 1664, 1665, 1669, 1673, 1703, and 1720.	11.45	17.47	22.61	40.07	35.53	12.95
1639	107	Beef, round, 1-inch cubes.....	12.68	21.87	30.79	52.66	18.27	16.40
1643	110	Beef, round, 3-inch cubes.....	15.18	21.52	26.82	48.34	20.83	15.64
1721	132	Beef, round, 1-inch cubes.....	15.38	19.21	27.79	47.00	24.75	12.89
		Average.....	14.41	20.87	28.47	49.33	21.28	14.98
1704	126	Beef, rump, 1-inch cubes.....	16.02	11.80	14.89	26.70	48.91	8.37
1652	114	Veal, leg, 1-inch cubes.....	23.60	23.15	33.21	56.36	2.36	17.64
		Average Nos. 1639, 1643, 1652, 1704, and 1721.....	16.57	19.51	26.70	46.21	23.02	14.19
		Average of all cooked 5 hours..	15.81	18.82	24.97	43.79	26.28	14.12
		Average of all cooked 3 and 5 hours.....	13.93	20.85	26.62	47.46	23.43	15.18
		Maximum.....	29.47	29.99	35.81	62.74	72.67	20.62
		Minimum.....	5.76	6.29	8.28	14.57	1.80	4.90

By referring to Table 130, page 189, it will be seen that the average composition of the 72 samples of meat broths, calculated to a common basis (100 grams of meat per 100 grams of broth, or 1 pound of meat per 1.04 pints of broth) was 96.64 per cent water, 3.36 per cent total solids, 0.33 per cent proteid, 0.58 per cent nitrogenous extractives, 0.74 per cent nonnitrogenous extractives, 1.32 per cent total organic

extractives, 1.25 per cent fat, and 0.45 per cent ash. The average amount of total nitrogen was 0.237 per cent, of which 0.052 per cent existed in proteid and 0.186 per cent in nonproteid form.

The total solid matter in the broths varied from 1.12 per cent to 10.27 per cent of the weight of the meat used. The smallest amount was found in broth No. 1163, from cooking experiment No. 33, in which a large piece of very fat beef neck was cooked at 100° C. for ten minutes and then at 80 to 85° C. for three hours. The total solids were composed of 0.12 per cent proteid, 0.22 per cent nitrogenous extractives, 0.31 per cent nonnitrogenous extractives, 0.53 per cent total organic extractives, 0.31 per cent fat and 0.16 per cent ash. Calculated to water-free basis, this broth residue had the following percentage composition: Proteid 10.71, nitrogenous extractives 10.64, nonnitrogenous extractives 27.68, total organic extractives 47.32, fat 27.68, and ash 14.28 per cent.

The largest quantity of solid matter was found in broth No. 1179, from cooking experiment No. 39, in which a small piece of leg of mutton was cooked at 100° C. for ten minutes and then at 80° to 85° C. for three hours. The 10.27 per cent total solids consisted of 0.22 per cent proteid, 0.61 per cent nitrogenous extractives, 0.77 per cent nonnitrogenous extractives, 8.25 per cent fat, and 0.42 per cent ash. Calculated to a water-free basis, the percentage composition was: Proteid 2.14, nitrogenous extractives 5.94, nonnitrogenous extractives 7.50, total organic extractives 13.44, fat 80.33, and ash 4.09 per cent.

The richness of broth, as measured by the total solids which it contains, seems to depend largely upon the sizes of the pieces of meat which are cooked. In other words, the smaller or the more finely divided the pieces of meat used, the richer the resulting broth. This may be readily noted in the detailed results given in Table 130.

The average amount of solid matter in the four broths (Nos. 1370, 1382, 1371, and 1383) for the preparation of which lean beef round, cut into one-half inch cubes, was cooked for ten minutes at 100° C. and for two hours at 80 to 85° C. was equal to 4.11 per cent of the weight of the meat taken for cooking. The average solid substances contained in the eleven broths, reported on page 187, for the preparation of which lean beef round, in small pieces weighing about 1.5 pounds, was cooked for ten minutes at 100° C. and for two hours at from 80 to 85° C. was equal to 3.50 per cent of the weight of the meat taken for cooking. The average quantity of total solid material in the last eight broths listed upon page 187, which were prepared by cooking large pieces of beef round, weighing on the average almost 4.5 pounds, for ten minutes at about 100° C. and then for two hours at from 80 to 85° C. was equal to only 2.24 per cent of the weight of the meat taken for cooking. Other experiments here reported confirm the conclusion expressed above, that the smaller the pieces of

meat (or the more finely divided the meat) used, the richer the resulting broth.

It is commonly supposed that if meat is placed in cold water, the temperature raised gradually and the cooking then continued as usual, more of its soluble ingredients are extracted and a richer broth obtained than when it is first put into boiling water and then cooked at a somewhat lower temperature. The earlier experiments<sup>a</sup> made under the auspices of this Office with meats cooked in hot water did not confirm this commonly accepted opinion. On the contrary, the results indicated clearly that the temperature of the water in which the meat was placed at the start had little influence upon the amount of material found in the broth. The data in Table 130<sup>1</sup> showing the detailed composition of the complete broths calculated to a uniform basis (1 pound of meat per 1.04 pints of broth) points clearly to this same conclusion, and also shows plainly the nature of the resulting broths when prepared by the two methods. For example, in the case of the 11 broths which were prepared by cooking small pieces of lean beef round, first for ten minutes in boiling water and then for two hours at from 80 to 85° C., the average weight of meat taken in these experiments was 659.20 grams, and the cooked meat contained upon an average 8.09 per cent of fat, and the average percentage composition of the broths was: Water 96.49, total solid matter 3.50, proteid 0.32, nitrogenous extractives 0.76, nonnitrogenous extractives 0.99, total organic extractives 1.75, fat 0.78, and ash 0.65 per cent. The average amount of total nitrogen was 0.294 per cent 0.52 per cent being in proteid and 0.243 per cent in nonproteid form. Calculated to a water-free basis, these broth residues had the following average composition: Proteid 9.20, nitrogenous extractives 21.76, nonnitrogenous extractives 28.42, total organic extractives 50.18, fat 22.10 per cent, and ash 18.52 per cent.

In the case of 4 broths prepared by putting small pieces of lean beef round in cold water, raising the temperature gradually to 80° C. and continuing the cooking for two hours and forty-five minutes longer at this temperature, the average weight of meat used was 777.22 grams and the cooked meat contained on an average 6.33 per cent of fat. The average composition of the 4 broths was: Water 96.65, total solid matter 3.35, proteid 0.35, nitrogenous extractives 0.77, nonnitrogenous extractives 1.02, total organic extractives 1.78, fat 0.65, and ash 0.57 per cent. The average amount of proteid nitrogen was 0.055 per cent and of nonproteid nitrogen 0.245 per cent, or 0.300 per cent total nitrogen. Calculated to a water-free basis, these broth residues had the following average composition: Proteid 10.47, nitrogenous extractives 23.24, nonnitrogenous extractives

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<sup>a</sup> U. S. Dept. Agr., Office of Experiment Stations Buls. 102, 141.

30.76, total organic extractives 54.00, fat 18.17, and ash 17.37 per cent. It is apparent from these figures that there is little difference in the composition of the broths resulting from the two different methods of preparation.

When the several constituents are considered separately, some variation in the different broths is noted, but it is by no means uniform enough for general deductions.

The total proteid in the broths varied from 0.05 per cent in sample No. 1175, prepared by cooking fresh ham for ten minutes at 100° C. and then for three hours at 80 to 85° C., to 1.20 per cent in sample No. 1380, prepared by placing beef round cut into one-half inch cubes in cold water, raising the temperature slowly to 48° C. and cooking at about this temperature for five hours.

Table 130 also gives the data regarding the composition of the total solid matter of the meat broths, calculated to a water-free basis. Expressed in this form the average percentage composition of the dry matter from the 73 complete broths was: 11.54 proteid, 19.51 nitrogenous extractives, 24.91 nonnitrogenous extractives, 44.42 total organic extractives, 28.68 fat, and 15.38 per cent ash. It is of interest to compare these figures with similar data for the composition of uncooked and boiled meats. The average percentage composition of 31 samples of meats cooked in contact with hot water, expressed on a water-free basis, was: 77.07 proteid, 1.43 nitrogenous extractives, 1.84 nonnitrogenous extractives, 3.27 total organic extractives, 20.17 fat, and 1.60 per cent ash. It is thus evident that the water-free substance of broths contained about one-seventh as much proteid, seven times as much nitrogenous and non-nitrogenous extractives, and fourteen times as much total organic extractives, somewhat more fat, and more than nine times as much mineral matter as the dry matter of boiled meat.

The average composition of 11 samples of raw meats on a water-free basis was: 62.59 proteid, 3.83 nitrogenous extractives, 5.78 non-nitrogenous extractives, 30.54 fat, and 3.59 per cent ash—that is, the water-free substance of broths, as compared with the water-free substance of uncooked meats, contains over one-sixth as much proteid, about four and one-half times as much of nitrogenous extractives, nonnitrogenous extractives, and total organic extractives, one and one-fourth as much fat, and three and eight-tenths as much ash.

The quantity of ash in the water-free substance of the broths varied from 2.32 per cent in sample No. 1161, to 24 per cent in sample No. 1380, the average being 15.38 per cent.

By referring to Table 131, page 195, it will be observed that the average results obtained in the years 1903 and 1904 from the analysis of 31 samples of complete meat broths were: Water 95.619 per cent, total solid matter 4.381 per cent, proteid 0.581 per cent, nitrog-



enous extractives 0.831 per cent, nonnitrogenous extractives 1.067 per cent, total organic extractives 1.898 per cent, fat 1.263 per cent, and ash 0.609 per cent.

The total nitrogen was 0.360 per cent, 0.093 per cent being proteid and 0.267 per cent in nonproteid form. The considerably higher result obtained in the last series as compared with the earlier tests reported is undoubtedly due to two causes. The first is the fact that in the experiments made in 1903-4 the meats were as a rule cut into small cubes, thus presenting a large surface to the solvent action of the water in which they were cooked, while in the earlier experiments the meats were as a rule cooked in compact pieces, many of them large in size. The second factor which apparently tended to give a richer broth in the later series of experiments is the longer time of cooking to which many of the meats were subjected.

Apparently, then, increasing the length of the cooking period increases the richness of the broth. Thus the average percentage composition of 14 broths cooked for three hours was: 96.163 water, 3.837 total solid matter, 0.456 proteid, 0.850 nitrogenous extractives, 1.054 nonnitrogenous extractives, 1.904 total organic extractives, 0.877 fat, and 0.603 per cent ash.

The average percentage composition of the 17 broths cooked for five hours was: 95.177 water, 4.823 total solid matter, 0.691 proteid, 0.814 nitrogenous extractives, 1.079 nonnitrogenous extractives, 1.893 total organic extractives, 1.593 fat, and 0.613 per cent ash. Since, however, the meats which were cooked for five hours contained almost twice as much fat as those cooked for three hours, this may be responsible for the large amount of fat in this broth.

The range in the proportion of the different constituents may be readily seen from the table. Such data are interesting, though they are not uniform enough for general deductions.

Table 131, page 196, also gives the percentage composition of the complete broths upon the basis of the water-free substance. Thus stated, the average percentage composition in the case of the 31 complete broths made by cooking small pieces of meat for comparatively long periods was: 13.93 proteid, 20.85 nitrogenous extractives, 26.62 nonnitrogenous extractives, 47.46 total organic extractives, 23.43 fat, and 15.18 per cent ash. On this basis of comparison it is apparent that the total solid matter of these broths contained considerably more proteid matter and nitrogenous and nonnitrogenous organic extractives and a somewhat smaller quantity of mineral substances and fat than did the total dry substance of the broths made by cooking larger pieces of meat for shorter periods.

In this connection it should be said that the true nature of the nitrogenous and nonnitrogenous extractives of broths and of meats



is as yet practically unknown. In our earlier investigations<sup>a</sup> upon the losses which meats sustain when cooked in hot water it was observed that the sum of the proteids, flesh bases, fat, and ash in clear broths as obtained by analysis was in all cases considerably less than the amount of total solids obtained by the direct evaporation, and this quantity of unknown extractives was designated "other substances." The proportion of the undetermined material or "other substances" ranged from 19.9 to 43.4 per cent, and averaged 34.2 per cent of the total solids of the clear broth; or, stated in another way, the proportion of unidentified substances in the broth varied from 0.3 to 1.1 per cent, and averaged 0.8 per cent of the total weight of the fresh meat.

Much time has been devoted in this laboratory to the study of undetermined substances in broths, but the publication of the detailed results is withheld until further investigations can be made. It is evident from the experimental results so far obtained that this material contains considerable lactic acid, some glycogen, more or less inosite and xanthin bases, and traces of acetic and butyric acids.

In the investigations reported in the later publication referred to above,<sup>b</sup> notwithstanding the fact that all the determinations of proteids, flesh bases, and "other substances" were carefully made, it was then considered more satisfactory in calculating the material lost in cooking meats to combine the flesh bases and the so-called "other substances" under the name of "extractives," a term which has often been used in that sense.<sup>c</sup>

Recent studies in connection with these nutrition investigations have shown that the cold-water extracts of meats also give results similar to those obtained in the analysis of broths, namely, that the sum of the nitrogenous matters, fat, and mineral matter determined by direct analysis is in every case decidedly less than the total solid residue obtained by direct evaporation. This difference may be seen by noting the proportion of the nonnitrogenous organic extractives in Tables 98-104, pages 99-115.

#### COMPOSITION OF CLEAR, FILTERED MEAT BROTHS.

The methods (see p. 15) used in the determination of the losses involved in the cooking of meats in hot water make it necessary to separate the constituents of the original complete broths into those which exist in the form of suspended matter and those which occur dissolved in the clear filtered broth. Broths are so frequently served clear that it seems desirable to present the available data regarding the

<sup>a</sup> U. S. Dept. Agr., Office of Experiment Stations Buls. 102, 141.

<sup>b</sup> U. S. Dept. Agr., Office of Experiment Stations Bul. 141.

<sup>c</sup> Mitchell's *Flesh Foods*, pp. 7, 45, and 48. See also Allen's *Commercial Organic Analysis*, vol. 4, Philadelphia, 1898, pp. 270 and 335; and Halliburton's *Textbook of Chemical Physiology and Pathology*, 1891, p. 418.

composition of the filtered broths, and in Tables 132 and 133 the composition of the clear, filtered broths, calculated to the basis that 100 grams of meat per 100 grams of broth or 1 pound of meat per 1.04 pints of original broth, will be found. The kind and cut of meat and the method of cooking are plainly shown in the tables, together with the weight of meat taken, the weight of the resulting complete broth, and the weight of the clear broth. The tables also give the percentage composition of the clear, filtered broth calculated to the basis of the water-free substance.

TABLE 132.—*Composition of clear, filtered broth. (Results of experiments made in 1898-1903.)*

[Calculated to the basis, 100 grams of meat give 100 grams of broth, or 1 pound of meat gives 1.04 pints of broth.]

Laboratory No.	Cooking experiment No.	Kind of meat.	Method of cooking.			Weight of meat taken.	Weight of suspended matter in broth.	Weight of clear broth.
			Temperature.		Duration of cooking.			
			At beginning.	During cooking.				
			°C.	°C.	Hours.	Grams.	Grams.	Grams.
1158	31	Beef, round, lean.....	100	80-85	1½	1,380.20	3.27	1,376.93
1095	28	.....do.....	100	100	2	1,211.75	21.34	1,190.41
1096	28	.....do.....	100	100	2	1,152.63	20.78	1,131.85
		Average Nos. 1095 and 1096.....				1,182.19	21.06	.....
1370	61	Beef, round, lean, ½-inch cubes..	100	80-85	2	500.00	8.03	491.97
1382	69	.....do.....	100	80-85	2	500.00	4.47	495.53
		Average.....				500.00	6.25	.....
1371	62	Beef, round, lean, ½-inch cubes..	100	80-85	2	2,500.00	43.73	2,456.27
1383	70	.....do.....	100	80-85	2	2,500.00	39.28	2,460.72
		Average.....				2,500.00	41.51	.....
		Average Nos. 1370, 1371, 1382, and 1383.....					23.88	.....
894	18	Beef, round, lean, small piece...	100	80-85	2	433.20	1.34	431.86
779b	21	.....do.....	100	80-85	2	660.50	5.16	655.34
809b	23	.....do.....	100	80-85	2	686.60	5.36	681.24
781b	22	.....do.....	100	80-85	2	755.80	3.81	751.99
		Average.....				634.03	3.92	.....
1378	65	Beef, round, lean, small piece...	100	80-85	2	501.41	5.73	495.68
779a	21	.....do.....	100	80-85	2	750.00	8.59	741.41
1386	73	.....do.....	100	80-85	2	500.00	4.81	495.19
809a	23	.....do.....	100	80-85	2	742.80	8.47	734.33
781a	22	.....do.....	100	80-85	2	657.00	6.16	650.84
777a	20	.....do.....	100	80-85	2	825.80	7.32	818.48
777b	20	.....do.....	100	80-85	2	739.50	7.11	732.39
		Average.....				673.79	6.88	.....
		Average Nos. 777a, 777b, 779a, 779b, 781a, 781b, 809a, 809b, 894, 1378, and 1386.....				659.33	5.80	.....
1211	51	Beef, round, lean, large piece...	100	80-85	2	2,141.09	1.39	2,139.70
1205	48	.....do.....	100	80-85	2	1,237.90	1.40	1,236.50
1242	54	.....do.....	100	80-85	2	2,108.62	2.98	2,105.64
895	18	.....do.....	100	80-85	2	2,080.60	4.69	2,075.91
		Average.....				1,892.05	2.62	.....

TABLE 132.—Composition of clear, filtered broth. (Results of experiments made in 1898–1903)—Continued.

Laboratory No.	Cooking experiment No.	Kind of meat.	Method of cooking.			Weight of meat taken.	Weight. of suspended matter. in broth.	Weight. of clear broth.
			Temperature.		Duration of cooking.			
			At beginning.	During cooking.				
			° C.	° C.	Hours.	Grams.	Grams.	Grams.
1379	66	Beef, round, lean, large piece . . .	100	80-85	2	2,502.60	19.60	2,483.00
1027	19	do . . . . .	100	80-85	2	2,141.25	11.54	2,129.71
1387	74	do . . . . .	100	80-85	2	2,500.00	13.26	2,486.74
1097	19	do . . . . .	100	80-85	2	1,139.48	3.88	1,135.60
Average . . . . .						2,070.83	12.07	.....
Average Nos. 895, 1027, 1097, 1205, 1211, 1242, 1379, and 1387 . . . . .						1,981.44	7.34	.....
892	16	Beef, round, fat . . . . .	100	80-85	2	1,220.30	10.64	1,209.66
893	16	do . . . . .	100	80-85	2	1,477.80	14.20	1,463.60
1091	26	do . . . . .	100	80-85	2	1,383.07	12.31	1,370.76
1092	26	do . . . . .	100	80-85	2	1,409.64	9.97	1,399.67
1172	35	do . . . . .	100	80-85	2	1,764.97	15.34	1,749.63
Average . . . . .						1,451.16	12.49	.....
1093	27	Beef, "plate boil," very fat . . . .	100	80-85	2	2,120.13	19.53	2,100.60
1094	27	do . . . . .	100	80-85	2	2,193.89	26.82	2,167.07
Average . . . . .						2,157.01	23.18	.....
1098	29	Beef, round, rather fat . . . . .	100	80-85	3	1,017.05	32.04	985.01
1099	29	do . . . . .	100	80-85	3	1,740.51	32.92	1,707.59
1146	30	do . . . . .	100	80-85	3	713.60	4.50	709.10
1147	30	do . . . . .	100	80-85	3	2,323.10	9.51	2,313.59
Average . . . . .						1,448.57	19.74	.....
1160	32	Beef, "plate boil," very fat . . . .	100	80-85	3	1,715.90	90.88	1,625.02
1161	32	do . . . . .	100	80-85	3	1,825.80	154.78	1,671.02
1162	33	Beef, neck, very fat . . . . .	100	80-85	3	2,393.20	20.94	2,372.26
1163	33	do . . . . .	100	80-85	3	2,729.80	9.12	2,720.68
1169	34	Beef, ribs, very fat . . . . .	100	80-85	3	1,806.37	52.74	1,753.63
1170	34	do . . . . .	100	80-85	3	1,923.58	56.15	1,867.43
Average of above . . . . .						2,065.78	64.10	.....
1177	38	Veal, leg . . . . .	100	80-85	3	1,774.20	14.94	1,759.26
1178	38	do . . . . .	100	80-85	3	2,334.70	4.26	2,330.44
1181	40	do . . . . .	100	80-85	3	1,648.31	3.30	1,645.01
1182	40	do . . . . .	100	80-85	3	1,939.09	2.67	1,936.42
Average . . . . .						1,924.08	6.29	.....
1179	39	Mutton, leg . . . . .	100	80-85	3	964.70	80.24	884.46
1180	39	do . . . . .	100	80-85	3	1,284.20	69.47	1,214.73
1183	41	do . . . . .	100	80-85	3	912.82	41.40	871.42
1184	41	do . . . . .	100	80-85	3	1,268.14	88.82	1,179.32
Average . . . . .						1,107.47	69.98	.....
1173	36	Pork, fresh ham . . . . .	100	80-85	3	1,838.40	9.22	1,829.18
1174	36	do . . . . .	100	80-85	3	1,608.50	73.46	1,535.04
1175	37	do . . . . .	100	80-85	3	1,882.66	26.98	1,855.68
1176	37	do . . . . .	100	80-85	3	2,016.70	38.93	1,977.77
Average . . . . .						1,836.57	37.15	.....
1206	48	Beef, round, lean . . . . .	100	80-85	5	1,210.15	1.11	1,209.04
1212	51	do . . . . .	100	80-85	5	1,529.94	6.01	1,523.93
1243	54	do . . . . .	100	80-85	5	1,128.00	3.53	1,124.47
Average . . . . .						1,289.36	3.55	.....
Average of 58 above . . . . .						1,481.86	22.41	.....
820a	24	Beef, round, lean . . . . .	20-25	50	6	915.10	5.75	909.35
820b	24	do . . . . .	20-25	50	6	837.30	6.90	830.40
Average . . . . .						876.20	6.33	.....

TABLE 132.—Composition of clear, filtered broth. (Results of experiments made in 1898-1903)—Continued.

Lab- ora- tory No.	Cook- ing ex- peri- ment No.	Kind of meat.	Method of cooking.			Weight of meat taken.	Weight. of sus- pended matter in broth.	Weight. of clear broth.
			Temperature.		Dura- tion of cook- ing.			
			At be- gin- ning.	During cook- ing.				
			° C.	° C.	Hours.	Grams.	Grams.	Grams.
1376	63	Beef, round, lean, 1 piece. ....	20-25	47-50	5	520.77	1.59	519.18
1384	71	.....do.....	20-25	47-50	5	500.00	2.92	497.08
		Average.....				510.39	2.26	
1377	64	Beef, round, lean, 1 piece. ....	20-25	47-50	5	2,384.54	9.75	2,374.79
1385	72	.....do.....	20-25	47-50	5	2,500.00	16.17	2,483.83
		Average.....				2,442.27	12.96	
1368	59	Beef, round, ½-inch cubes .....	20-25	47-50	5	500.00	2.30	497.70
1380	67	.....do.....	20-25	47-50	5	500.00	6.08	493.92
		Average.....				500.00	4.19	
1369	60	Beef, round, ½-inch cubes .....	20-25	47-50	5	2,500.00	18.42	2,481.58
1381	68	.....do.....	20-25	47-50	5	2,500.00	14.67	2,485.33
		Average.....				2,500.00	16.55	
		Average Nos. 1368, 1369, 1370, 1377, 1380, 1381, 1384, and 1385 .....				1,488.16	8.99	
1171	35	Beef, round, lean .....	20-25	57-60	5	1,523.68	8.35	1,515.33
771a	17	.....do.....	20-25	80	23	705.50	7.34	698.16
771b	17	.....do.....	20-25	80	23	660.80	9.54	651.26
823a	25	.....do.....	20-25	80	23	798.10	3.00	795.10
823b	25	.....do.....	20-25	80	23	944.50	6.68	937.82
		Average Nos. 771a, 771b, 823a, and 823b.....				777.23	6.64	
		Average Nos. 771a, 771b, 820a, 820b, 823a, 823b, 1171, 1368, 1369, 1376, 1377, 1380, 1381, 1384, and 1385 .....				1,219.35	7.96	
		Average of 73 above .....				1,427.92	19.45	
		Maximum .....				2,729.80	154.78	
		Minimum .....				500.00	1.11	

Lab- ora- tory No.	Cook- ing ex- peri- ment No.	Kind of meat.	Percentage composition of the clear, filtered broth.						Ash.
			Water.	Total solid mat- ter.	Pro- teid.	Organic extractives.			
						Nitrog- enous.	Non- nitrog- enous.	Total.	
1158	31	Beef round, lean.....	Per ct. 98.40	Per ct. 1.60	Per ct. 0.08	Per ct. 0.46	Per ct. 0.71	Per ct. 1.17	Per ct. 0.35
1095	28	.....do.....	97.43	2.57	.12	.75	1.07	1.82	.63
1096	28	.....do.....	97.48	2.52	.16	.75	1.02	1.77	.59
		Average Nos. 1095 and 1096.....	97.45	2.55	.14	.75	1.05	1.80	.61
1370	61	Beef, round, lean, ½-inch cubes.....	97.22	2.78	.20	.84	1.06	1.90	.68
1382	69	.....do.....	97.22	2.78	.06	.95	1.12	2.07	.65
		Average.....	97.22	2.78	.13	.89	1.09	1.98	.67

TABLE 132.—Composition of clear, filtered broth. (Results of experiments made in 1898-1903)—Continued.

Lab- ora- tory No.	Cook- ing ex- peri- ment No.	Kind of meat.	Percentage composition of the clear, filtered broth.						Ash.
			Water.	Total solid mat- ter.	Pro- teid.	Organic extractives.			
						Nitrog- enous.	Non- nitrog- enous.	Total.	
1371	62	Beef, round, lean, $\frac{1}{2}$ -inch cubes.....	<i>Per ct.</i> 97.42	<i>Per ct.</i> 2.58	<i>Per ct.</i> 0.11	<i>Per ct.</i> 0.84	<i>Per ct.</i> 1.00	<i>Per ct.</i> 1.84	<i>Per ct.</i> 0.63
1383	70	do.....	97.36	2.64	.06	.89	1.07	1.96	.62
		Average.....	97.39	2.61	.08	.87	1.03	1.90	.63
		Average Nos. 1370, 1371, 1382, and 1383.....	97.30	2.70	.11	.88	1.06	1.94	.65
894	18	Beef, round, lean, small piece	97.07	2.93	.12	.90	1.18	2.08	.73
779b	21	do.....	97.05	2.95	.43	.80	1.04	1.84	.68
809b	23	do.....	97.31	2.69	.12	.80	1.12	1.92	.65
781b	22	do.....	97.33	2.67	.30	.75	.99	1.74	.63
		Average.....	97.19	2.81	.24	.81	1.09	1.90	.67
1378	65	Beef, round, lean, small piece	97.66	2.34	.09	.77	.83	1.60	.65
779a	21	do.....	97.28	2.72	.40	.74	.93	1.67	.65
1386	73	do.....	97.48	2.52	.06	.81	.98	1.79	.67
809a	23	do.....	97.49	2.51	.15	.73	1.01	1.74	.62
781a	22	do.....	97.34	2.66	.33	.68	1.03	1.71	.62
777a	20	do.....	97.51	2.49	.28	.68	.92	1.60	.61
777b	20	do.....	97.29	2.71	.36	.77	.96	1.73	.62
		Average.....	97.44	2.56	.24	.74	.95	1.69	.63
		Average Nos. 777a, 777b, 779a, 779b, 781a, 781b, 809a, 809b, 894, 1378, and 1386.....	97.35	2.65	.24	.77	1.00	1.77	.65
1211	51	Beef, round, lean, large piece.	98.35	1.65	.14	.51	.60	1.11	.40
1205	48	do.....	98.17	1.83	.08	.56	.74	1.30	.45
1242	54	do.....	98.67	1.33	.11	.41	.47	.88	.34
895	18	do.....	97.54	2.46	.12	.74	1.01	1.75	.59
		Average.....	98.18	1.82	.11	.56	.71	1.26	.45
1379	66	Beef, round, lean, large piece.	98.01	1.99	.11	.64	.82	1.46	.42
1027	19	do.....	97.71	2.29	.13	.86	.75	1.61	.55
1387	74	do.....	98.51	1.49	.13	.58	.42	1.00	.36
1097	19	do.....	97.84	2.16	.13	.70	.85	1.55	.48
		Average.....	98.02	1.98	.13	.70	.71	1.41	.45
		Average Nos. 895, 1027, 1097, 1205, 1211, 1242, 1379, and 1387.....	98.10	1.90	.12	.63	.71	1.34	.45
892	16	Beef, round, fat.....	98.24	1.76	.11	.54	.66	1.20	.45
893	16	do.....	98.27	1.73	.16	.51	.64	1.15	.42
1091	26	do.....	98.04	1.96	.10	.60	.80	1.40	.46
1092	26	do.....	98.32	1.68	.14	.50	.66	1.16	.38
1172	35	do.....	98.72	1.28	.07	.37	.54	.91	.30
		Average.....	98.32	1.68	.12	.50	.66	1.16	.40
1093	27	Beef, "plate boil," very fat.	99.12	.88	.08	.25	.34	.59	.21
1094	27	do.....	99.27	.73	.05	.18	.34	.52	.16
		Average.....	99.20	.81	.07	.22	.34	.56	.19
1098	29	Beef, round, rather fat.....	97.64	2.36	.20	.64	1.02	1.66	.50
1099	29	do.....	98.14	1.86	.16	.51	.78	1.29	.41
1146	30	do.....	97.75	2.25	.12	.69	.93	1.62	.51
1147	30	do.....	98.19	1.81	.09	.55	.73	1.28	.44
		Average.....	97.93	2.07	.14	.60	.86	1.46	.47



TABLE 132.—*Composition of clear, filtered broth. (Results of experiments made in 1898-1903)—Continued.*

Lab- ora- tory No.	Cook- ing ex- per- iment No.	Kind of meat.	Percentage composition of the clear, filtered broth.						Ash.
			Water.	Total solid mat- ter.	Pro- teid.	Organic extractives.			
						Nitrog- enous.	Non- nitrog- enous	Total.	
			<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	
1160	32	Beef, "plate boil," very fat..	99.14	0.86	0.07	0.24	0.37	0.61	0.18
1161	32	.....do.....	98.89	1.11	.07	.31	.49	.80	.24
1162	33	Beef, neck, very fat.....	99.04	.96	.11	.27	.38	.65	.20
1163	33	.....do.....	99.21	.79	.10	.22	.31	.53	.16
1169	34	Beef, ribs, very fat.....	98.77	1.23	.12	.36	.49	.85	.26
1170	34	.....do.....	98.97	1.03	.11	.31	.39	.70	.22
		Average of above.....	99.00	1.00	.10	.29	.40	.69	.21
1177	38	Veal, leg.....	98.21	1.79	.35	.45	.64	1.09	.35
1178	38	.....do.....	98.48	1.52	.33	.39	.50	.89	.30
1181	40	.....do.....	97.98	2.02	.35	.48	.81	1.29	.38
1182	40	.....do.....	98.42	1.58	.34	.37	.57	.94	.30
		Average.....	98.27	1.73	.34	.42	.63	1.05	.33
1179	39	Mutton, leg.....	97.87	2.13	.16	.67	.84	1.51	.46
1180	39	.....do.....	98.00	2.00	.21	.58	.81	1.39	.40
1183	41	.....do.....	98.10	1.90	.12	.47	.91	1.38	.40
1184	41	.....do.....	98.28	1.72	.15	.40	.81	1.21	.36
		Average.....	98.06	1.94	.16	.53	.84	1.37	.41
1173	36	Pork, fresh ham.....	99.00	1.00	.11	.28	.39	.67	.22
1174	36	.....do.....	98.84	1.16	.06	.35	.50	.85	.25
1175	37	.....do.....	98.92	1.08	.05	.33	.43	.76	.27
1176	37	.....do.....	98.86	1.14	.05	.35	.46	.81	.28
		Average.....	98.90	1.10	.07	.33	.44	.77	.26
1206	48	Beef, round, lean.....	97.49	2.51	.09	.79	1.03	1.82	.60
1212	51	.....do.....	97.78	2.22	.17	.67	.83	1.50	.55
1243	54	.....do.....	98.12	1.88	.15	.60	.66	1.26	.47
		Average.....	97.80	2.20	.14	.69	.84	1.53	.54
		Average of 58 above....	98.07	1.93	.15	.57	.74	1.31	.45
820a	24	Beef, round, lean.....	98.34	1.66	.24	.44	.61	1.05	.37
820b	24	.....do.....	97.71	2.29	.41	.57	.84	1.41	.47
		Average.....	98.02	1.98	.33	.51	.73	1.23	.42
1376	63	Beef, round, lean, 1 piece.....	97.75	2.25	.50	.56	.64	1.20	.55
1384	71	.....do.....	97.56	2.44	.45	.69	.81	1.50	.49
		Average.....	97.65	2.35	.48	.63	.73	1.35	.52
1377	64	Beef, round, lean, 1 piece.....	98.19	1.81	.33	.50	.58	1.08	.40
1385	72	.....do.....	98.60	1.40	.20	.42	.47	.89	.31
		Average.....	98.39	1.61	.27	.46	.53	.99	.36
1368	59	Beef, round, 1/2-inch cubes.....	97.34	2.66	.22	.84	.98	1.82	.62
1380	67	.....do.....	98.45	1.55	.18	.47	.24	.71	.66
		Average.....	97.89	2.11	.20	.66	.61	1.27	.64
1369	60	Beef, round, 1/2-inch cubes.....	97.82	2.18	.31	.68	.69	1.37	.50
1381	68	.....do.....	97.61	2.39	.38	.71	.83	1.54	.47
		Average.....	97.71	2.29	.34	.70	.76	1.46	.49
		Average Nos. 1368, 1369, 1376, 1377, 1380, 1381, 1384, and 1385....	97.92	2.08	.32	.61	.65	1.26	.50

TABLE 132.—*Composition of clear, filtered broth. (Results of experiments made in 1898-1903)—Continued.*

Laboratory No.	Cooking experiment No.	Kind of meat.	Percentage composition of the clear, filtered broth.						Ash.
			Water.	Total solid matter.	Proteid.	Organic extractives.			
						Nitrogenous.	Non-nitrogenous.	Total.	
1171	35	Beef, round, lean.....	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
771a	17	.....do.....	98.61	1.39	0.08	0.41	0.55	0.96	0.35
771b	17	.....do.....	97.52	2.48	.06	.79	1.06	1.85	.57
823a	25	.....do.....	97.46	2.54	.09	.77	1.08	1.85	.60
823b	25	.....do.....	97.54	2.46	.11	.78	.99	1.77	.58
		.....do.....	97.59	2.41	.15	.74	.97	1.71	.55
		Average Nos. 771a, 771b, 823a, and 823b....	97.53	2.47	.10	.77	1.02	1.79	.58
		Average Nos. 771a, 771b, 820a, 820b, 823a, 823b, 1171, 1368, 1369, 1376, 1377, 1380, 1381, 1384, and 1385.....	97.87	2.13	.25	.62	.75	1.38	.50
		Average of 73 above.....	98.03	1.97	.17	.59	.74	1.34	.46
		Maximum.....	99.27	2.95	.50	.95	1.18	2.08	.73
		Minimum.....	97.05	.73	.05	.18	.24	.52	.16

Laboratory No.	Cooking experiment No.	Kind of meat.	Percentage composition of the clear, filtered broth. (Water-free substance.)					Ash.
			Proteid.	Organic extractives.				
				Nitrogenous.	Non-nitrogenous.	Total.		
1158	31	Beef, round, lean.....	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	
1095	28	.....do.....	5.00	28.75	44.38	73.13	21.87	
1096	28	.....do.....	4.67	29.18	41.64	70.82	24.51	
		.....do.....	6.35	29.76	40.48	70.24	23.41	
		Average Nos. 1095 and 1096....	5.51	29.47	41.06	70.53	23.96	
1370	61	Beef, round, lean, ½-inch cubes.....	7.19	30.22	38.13	68.35	24.46	
1382	69	.....do.....	2.16	34.17	40.29	74.46	23.38	
		Average.....	4.68	32.20	39.21	71.40	23.92	
1371	62	Beef, round, lean, ½-inch cubes.....	4.26	32.56	38.76	71.32	24.42	
1383	70	.....do.....	2.27	33.71	40.53	74.24	23.49	
		Average.....	3.26	33.14	39.64	72.78	23.96	
		Average Nos. 1370, 1371, 1382, and 1383.....	3.97	32.67	39.42	72.09	23.94	
894	18	Beef, round, lean, small piece.....	4.10	30.72	40.27	70.99	24.91	
779b	21	.....do.....	14.58	27.12	35.25	62.37	23.05	
809b	23	.....do.....	4.46	29.74	41.64	71.38	24.16	
781b	22	.....do.....	11.24	28.09	37.08	65.17	23.59	
		Average.....	8.59	28.92	38.56	67.48	23.93	
1378	65	Beef, round, lean, small piece.....	3.84	32.91	35.47	68.38	27.78	
779a	21	.....do.....	14.71	27.21	34.19	61.40	23.90	
1386	73	.....do.....	2.38	32.14	38.89	71.03	26.59	
809a	23	.....do.....	5.98	29.08	40.24	69.32	24.70	
781a	22	.....do.....	12.41	25.56	38.72	64.28	23.31	
777a	20	.....do.....	11.24	27.31	36.95	64.26	24.50	
777b	20	.....do.....	13.28	28.41	35.42	63.84	22.88	
		Average.....	9.12	28.95	37.13	66.07	24.81	
		Average Nos. 777a, 777b, 779a, 779b, 781a, 781b, 809a, 809b, 894, 1378, and 1386.....	8.93	28.94	37.65	66.58	24.49	

TABLE 132.—Composition of clear, filtered broth. (Results of experiments made in 1898-1903)—Continued.

Laboratory No.	Cooking-experiment No.	Kind of meat.	Percentage composition of the clear, filtered broth. (Water-free substance.)				
			Proteid.	Organic extractives.			Ash.
				Nitrogenous.	Non-nitrogenous.	Total.	
			<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1211	51	Beef, round, lean, large piece.....	8.49	30.91	36.36	67.27	24.24
1205	48	.....do.....	4.37	30.60	40.44	71.04	24.59
1242	54	.....do.....	8.27	30.83	35.34	66.17	25.56
895	18	.....do.....	4.88	30.08	41.06	71.14	23.98
		Average.....	6.50	30.61	38.30	68.91	24.59
1379	66	Beef, round, lean, large piece.....	5.53	32.16	41.21	73.37	21.10
1027	19	.....do.....	5.67	37.55	32.75	70.31	24.02
1387	74	.....do.....	8.73	38.92	28.19	67.11	24.16
1097	19	.....do.....	6.02	32.41	39.35	71.76	22.22
		Average.....	6.49	35.26	35.38	70.64	22.88
		Average Nos. 895, 1027, 1097, 1205, 1211, 1242, 1379, and 1387.....	6.50	32.94	36.84	69.78	23.73
892	16	Beef, round, fat.....	6.25	30.68	37.50	68.18	25.57
893	16	.....do.....	9.25	29.48	36.99	66.47	24.28
1091	26	.....do.....	5.10	30.61	40.81	71.43	23.47
1092	26	.....do.....	8.33	29.76	39.28	69.05	22.62
1172	35	.....do.....	5.47	28.91	42.19	71.09	23.44
		Average.....	6.88	29.89	39.35	69.24	23.88
1093	27	Beef, "plate boil," very fat.....	9.09	28.41	38.64	67.05	23.86
1094	27	.....do.....	6.85	24.66	46.57	71.23	21.92
		Average.....	7.97	26.54	42.60	69.14	22.89
1098	29	Beef, round, rather fat.....	8.48	27.12	43.22	70.34	21.18
1099	29	.....do.....	8.60	27.42	41.94	69.36	22.04
1146	30	.....do.....	5.33	30.67	41.33	72.00	22.67
1147	30	.....do.....	4.97	30.39	40.33	70.72	24.31
		Average.....	6.85	28.90	41.70	70.60	22.55
1160	32	Beef, "plate boil," very fat.....	8.14	27.91	43.02	70.93	20.93
1161	32	.....do.....	6.31	27.93	44.14	72.07	21.62
1162	33	Beef, neck, very fat.....	11.46	28.13	39.58	67.71	20.83
1163	33	.....do.....	12.66	27.85	39.24	67.09	20.25
1169	34	Beef, ribs, very fat.....	9.75	29.27	39.84	69.11	21.14
1170	34	.....do.....	10.68	30.10	37.86	67.96	21.36
		Average of above.....	9.83	28.53	40.62	69.15	21.02
1177	38	Veal, leg.....	19.56	25.14	35.75	60.89	19.55
1178	38	.....do.....	21.71	25.66	32.89	58.55	19.74
1181	40	.....do.....	17.33	23.76	40.10	63.86	18.81
1182	40	.....do.....	21.52	23.42	36.07	59.49	18.99
		Average.....	20.03	24.50	36.20	60.70	19.27
1179	39	Mutton, leg.....	7.51	31.46	39.43	70.89	21.60
1180	39	.....do.....	10.50	29.00	40.50	69.50	20.00
1183	41	.....do.....	6.32	24.74	47.89	72.63	21.05
1184	41	.....do.....	8.72	23.26	47.09	70.35	20.93
		Average.....	8.26	27.11	43.73	70.84	20.90
1173	36	Pork, fresh ham.....	11.00	28.00	39.00	67.00	22.00
1174	36	.....do.....	5.17	30.18	43.10	73.28	21.55
1175	37	.....do.....	4.63	30.56	39.81	70.37	25.00
1176	37	.....do.....	4.39	30.70	40.35	71.05	24.56
		Average.....	6.30	29.86	40.56	70.42	23.28

TABLE 132.—Composition of clear, filtered broth. (Results of experiments made in 1898-1903)—Continued.

Lab- ora- tory No.	Cook- ing- ex- peri- ment No.	Kind of meat.	Percentage composition of the clear, filtered broth. (Water-free substance.)				
			Pro- teid.	Organic extractives.			Ash.
				Nitrog- enous.	Non- nitrog- enous.	Total.	
			<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>	<i>Per ct.</i>
1206	48	Beef, round, lean.....	3.59	31.47	41.04	72.51	23.90
1212	51	do.....	7.66	30.18	37.38	67.57	24.77
1243	54	do.....	7.98	31.91	35.11	67.02	25.00
		Average.....	6.41	31.19	37.84	69.03	24.56
		Average of 58 above.....	8.21	29.46	39.34	68.79	22.99
820a	24	Beef, round, lean.....	14.46	26.51	36.75	63.25	22.29
820b	24	do.....	17.91	24.89	36.68	61.57	20.52
		Average.....	16.19	25.70	36.72	62.41	21.40
1376	63	Beef, round, lean, 1 piece.....	22.22	24.89	28.44	53.33	24.45
1384	71	do.....	18.44	28.28	33.20	61.48	20.08
		Average.....	20.33	26.58	30.82	57.40	22.27
1377	64	Beef, round, lean, 1 piece.....	18.23	27.62	32.05	59.67	22.10
1385	72	do.....	14.29	30.00	33.57	63.57	22.14
		Average.....	16.26	28.81	32.81	61.62	22.12
1368	59	Beef, round, ½-inch cubes.....	8.27	31.58	36.84	68.42	23.31
1380	67	do.....	11.61	30.32	15.49	45.81	42.58
		Average.....	9.94	30.95	26.17	57.12	32.94
1369	60	Beef, round, ½-inch cubes.....	14.22	31.19	31.65	62.84	22.94
1381	68	do.....	15.90	29.71	34.73	64.44	19.66
		Average.....	15.06	30.45	33.19	63.64	21.30
		Average Nos. 1368, 1369, 1376, 1377, 1380, 1381, 1384, and 1385.	15.40	29.20	30.75	59.95	24.66
1171	35	Beef, round, lean.....	5.76	29.49	39.57	69.06	25.18
771a	17	do.....	2.42	31.85	42.74	74.59	22.99
771b	17	do.....	3.54	30.32	42.52	72.84	23.62
823a	25	do.....	4.47	31.71	40.24	71.95	23.58
823b	25	do.....	6.22	30.70	40.25	70.95	22.83
		Average Nos. 771a, 771b, 823a, and 823b.....	4.16	31.14	41.44	72.58	23.26
		Average Nos. 771a, 771b, 820a, 820b, 823a, 823b, 1171, 1368, 1369, 1376, 1377, 1380, 1381, 1384, and 1385.....	11.86	29.27	34.98	64.25	23.89
		Average of 73 above.....	8.96	29.42	38.44	67.86	23.18
		Maximum.....	22.22	38.92	47.89	74.59	32.94
		Minimum.....	2.16	23.26	15.49	57.12	18.81

TABLE 133.—*Composition of clear, filtered broth. (Results of experiments made in 1903-1904.)*

[Calculated to the basis, 100 grams of meat give 100 grams of broth, or 1 pound of meat gives 1.04 pints of broth.]

Cooking experiment No.	Laboratory No.	Kind of meat.	Method of cooking.			Weight of meat taken.	Weight of suspended matter in broth.	Weight of clear broth.
			Temperature.		Duration of cooking.			
			At beginning.	During cooking.				
			°C.	°C.	Hours.	Grams.	Grams.	Grams.
109	1642	Beef, round, 1-inch cubes.....	Cold.	85	3	1,000.00	19.79	980.21
137	1754	Beef, round, 2-inch cubes.....	Cold.	85	3	900.00	11.12	888.88
		Average.....	Cold.	85	3	.....	15.46	934.55
139	1756	Beef, round, browned, 2-inch cubes.....	Cold.	85	3	900.00	6.62	893.38
		Average Nos. 1642, 1754, and 1756.....	Cold.	85	3	.....	12.51	920.82
136	1746	Beef, round, browned, 2-inch cubes.....	85	85	3	1,000.00	17.53	982.47
145	1772	Beef, round, 2-inch cubes.....	85	85	3	1,074.83	5.56	1,069.27
154	1783	.....do.....	85	85	3	1,052.17	.....	.....
		Average Nos. 1772 and 1783.....	85	85	3	.....	11.55	1,025.87
108	1641	Beef, round, 1-inch cubes.....	100	85	3	1,000.00	10.37	989.63
134	1744	Beef, round, 2-inch cubes.....	100	85	3	1,000.00	3.70	996.30
		Average.....	100	85	3	.....	7.04	992.97
144	1773	Beef, round, 1 piece.....	100	85	3	1,027.72	2.34	1,025.38
153	1784	.....do.....	100	85	3	1,098.31	4.44	1,093.87
		Average.....	100	85	3	.....	3.39	1,059.63
		Average Nos. 1641, 1744, 1773, and 1784.....	100	85	3	.....	5.21	1,026.30
138	1755	Beef, round, 2-inch cubes.....	Cold.	100	3	900.00	17.38	882.62
140	1757	Beef, round, browned, 2-inch cubes.....	Cold.	100	3	900.00	6.99	893.01
		Average.....	Cold.	100	3	.....	12.19	887.82
133	1743	Beef, round, 2-inch cubes.....	100	100	3	1,000.00	5.03	994.97
135	1745	Beef, round, browned, 2-inch cubes.....	100	100	3	1,000.00	25.80	974.20
		Average.....	100	100	3	.....	15.42	984.59
		Average of all cooked 3 hours.....	.....	.....	3	.....	10.51	974.17
113	1646	Beef, round, ¾-inch cubes.....	Cold.	65	5	1,000.00	13.74	986.26
112	1645	.....do.....	Cold.	85	5	1,000.00	17.95	982.05
116	1654	Veal, leg, 1-inch cubes.....	Cold.	85	5	1,000.00	7.98	992.02
118	1658	.....do.....	Cold.	85	5	1,000.00	10.68	989.32
		Average Nos. 1654 and 1658.....	Cold.	85	5	.....	9.33	990.67
		Average Nos. 1645, 1654, and 1658.....	Cold.	85	5	.....	12.20	987.80
111	1644	Beef, round, ¾-inch cubes.....	100	85	5	1,000.00	11.94	988.06
131	1720	Beef, round, 1-inch cubes.....	100	85	5	1,000.00	14.03	985.97
		Average.....	100	85	5	.....	12.99	987.02
121	1665	Beef, neck, ¾-inch cubes.....	100	85	5	700.00	8.58	691.42
123	1673	Beef, rump, 1-inch cubes.....	100	85	5	1,000.00	65.04	934.96
125	1703	.....do.....	100	85	5	1,000.00	24.66	975.34
		Average Nos. 1673 and 1703.....	100	85	5	.....	44.85	955.15



TABLE 133.—*Composition of clear, filtered broth. (Results of experiments made in 1903-1904)*—Continued.

Cook- ing. ex- peri- ment No.	Lab- ora- tory No.	Kind of meat.	Method of cooking.			Weight of meat taken.	Weight of sus- pended matter in broth.	Weight of clear broth.
			Temperature.		Dura- tion of cook- ing.			
			At be- gin- ing.	During cook- ing.				
			° C.	° C.	Hours.	Grams.	Grams.	Grams.
122	1669	Beef, flank, $\frac{3}{4}$ -inch cubes.....	100	85	5	1,000.00	65.71	934.29
115	1653	Veal, leg, 1-inch cubes.....	100	85	5	1,000.00	2.93	997.07
117	1664	.....do.....	100	85	5	1,000.00	4.67	995.33
		Average Nos. 1653 and 1664.....	100	85	5	.....	3.80	996.20
		Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	100	85	5	.....	24.70	937.81
107	1639	Beef, round, 1-inch cubes.....	100	100	5	1,000.00	9.15	990.85
110	1643	Beef, round, $\frac{3}{4}$ -inch cubes.....	100	100	5	1,000.00	10.60	989.40
132	1721	Beef, round, 1-inch cubes.....	100	100	5	1,000.00	12.40	987.60
		Average.....	100	100	5	.....	10.72	989.28
126	1704	Beef, rump, 1-inch cubes.....	100	100	5	1,000.00	32.25	967.75
114	1652	Veal, leg, 1-inch cubes.....	100	100	5	1,000.00	2.07	997.93
		Average Nos. 1639, 1643, 1652, 1704, and 1721.....	100	100	5	.....	13.29	986.71
		Average of all cooked 5 hours.....	.....	.....	5	.....	18.49	963.86
		Average of all cooked 3 and 5 hours.....	.....	.....	.....	.....	15.03	968.33
		Maximum.....	.....	.....	.....	1,098.31	65.71	1,093.87
		Minimum.....	.....	.....	.....	700.00	2.07	691.42

Cook- ing ex- peri- ment No.	Lab- ora- tory No.	Kind of meat.	Percentage composition of clear, filtered broth.						
			Water.	Total solid mat- ter.	Pro- teid.	Organic extractives.			Ash.
						Nitrog- enous.	Non- nitrog- enous.	Total.	
			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
109	1642	Beef, round, 1-inch cubes.....	96.63	3.37	0.18	1.04	1.37	2.41	0.79
137	1754	Beef, round, 2-inch cubes.....	97.28	2.72	.18	.87	1.07	1.94	.60
		Average.....	96.96	3.05	.18	.96	1.22	2.18	.70
139	1756	Beef, round, browned, 2-inch cubes.....	97.27	2.73	.17	.88	1.07	1.95	.61
		Average Nos. 1642, 1754, and 1756.....	97.06	2.94	.18	.93	1.17	2.10	.67
136	1746	Beef, round, browned, 2-inch cubes.....	97.20	2.80	.22	.85	1.11	1.96	.61
145	1772	Beef, round, 2-inch cubes.....	97.72	2.28	.17	.75	.84	1.59	.52
154	1783	.....do.....	.....	.....	.....	.....	.....	.....	.....
		Average Nos. 1772 and 1783.....	97.46	2.54	.20	.80	.98	1.78	.57
108	1641	Beef, round, 1-inch cubes.....	96.57	3.43	.22	1.07	1.37	2.44	.76
134	1744	Beef, round, 2-inch cubes.....	97.05	2.95	.28	.87	1.19	2.06	.61
		Average.....	96.81	3.19	.25	.97	1.28	2.25	.69
144	1773	Beef, round, 1 piece.....	97.98	2.02	.15	.67	.74	1.41	.46
153	1784	.....do.....	97.70	2.30	.16	.74	.88	1.62	.52
		Average.....	97.84	2.16	.16	.71	.81	1.52	.49
		Average Nos. 1641, 1744, 1773, and 1784.....	97.33	2.68	.20	.84	1.05	1.89	.59

TABLE 133.—*Composition of clear, filtered broth. (Results of experiments made in 1903-1904)*—Continued.

Cook- ing ex- periment No.	Lab- ora- tory No.	Kind of meat.	Percentage composition of clear, filtered broth.						
			Water.	Total solid mat- ter.	Pro- teid.	Organic extractives.			Ash.
						Nitrog- enous.	Non- nitrog- enous.	Total.	
138	1755	Beef, round, 2-inch cubes . . .	<i>Per ct.</i> 97.10	<i>Per ct.</i> 2.90	<i>Per ct.</i> 0.26	<i>Per ct.</i> 0.91	<i>Per ct.</i> 1.08	<i>Per ct.</i> 1.99	<i>Per ct.</i> 0.64
140	1757	Beef, round, browned, 2-inch cubes . . . . .	97.12	2.88	.25	.89	1.09	1.98	.64
		Average . . . . .	97.11	2.89	.26	.90	1.09	1.99	.64
133	1743	Beef, round, 2-inch cubes . . .	97.02	2.98	.35	.89	1.12	2.01	.62
135	1745	Beef, round, browned, 2-inch cubes . . . . .	97.14	2.86	.34	.84	1.09	1.93	.58
		Average . . . . .	97.08	2.92	.35	.86	1.11	1.97	.60
		Average of all cooked 3 hours . . . . .	97.21	2.79	.23	.87	1.08	1.95	.61
113	1646	Beef, round, ¾-inch cubes . . .	96.88	3.12	.24	.93	1.21	2.14	.75
112	1645	do . . . . .	96.82	3.18	.15	1.01	1.29	2.30	.74
116	1654	Veal, leg, 1-inch cubes . . . .	97.06	2.94	.41	.76	1.15	1.91	.63
118	1658	do . . . . .	97.13	2.87	.46	.80	.97	1.77	.64
		Average Nos. 1654 and 1658 . . . . .	97.10	2.91	.44	.78	1.06	1.84	.64
		Average Nos. 1645, 1654, and 1658 . . . . .	97.00	3.00	.34	.86	1.14	2.00	.67
111	1644	Beef, round, ¾-inch cubes . . .	96.93	3.07	.22	.93	1.21	2.14	.71
131	1720	Beef, round, 1-inch cubes . . .	96.75	3.25	.29	.96	1.36	2.32	.64
		Average . . . . .	96.84	3.16	.26	.94	1.29	2.23	.68
121	1665	Beef, neck, ¾-inch cubes . . .	97.07	2.93	—	—	—	—	.68
123	1673	Beef, rump, 1-inch cubes . . .	97.56	2.44	.34	.65	.92	1.57	.53
125	1703	do . . . . .	97.11	2.89	.35	.88	1.05	1.93	.61
		Average Nos. 1673 and 1703 . . . . .	97.34	2.67	.35	.76	.99	1.76	.57
122	1669	Beef, flank, ¾-inch cubes . . .	97.49	2.51	.65	.60	.79	1.39	.47
115	1653	Veal, leg, 1-inch cubes . . . .	97.12	2.88	.27	.85	1.13	1.98	.63
117	1664	do . . . . .	97.18	2.82	.50	.78	.92	1.70	.62
		Average Nos. 1653 and 1664 . . . . .	97.15	2.85	.39	.81	1.03	1.84	.63
		Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720 . . .	97.15	2.85	.38	.81	1.05	1.86	.61
107	1639	Beef, round, 1-inch cubes . . .	96.83	3.17	.34	.89	1.26	2.15	.67
110	1643	Beef, round, ¾-inch cubes . . .	96.96	3.04	.41	.89	1.10	1.99	.64
132	1721	Beef, round, 1-inch cubes . . .	96.61	3.39	.61	.89	1.29	2.18	.60
		Average . . . . .	96.80	3.20	.45	.89	1.22	2.11	.64
126	1704	Beef, rump, 1-inch cubes . . .	96.81	3.19	.90	.77	.97	1.74	.54
114	1652	Veal, leg, 1-inch cubes . . . .	97.32	2.68	.55	.67	.96	1.63	.51
		Average Nos. 1639, 1643, 1652, 1704, and 1721 . . .	96.91	3.09	.56	.82	1.12	1.94	.59
		Average of all cooked 5 hours . . . . .	97.04	2.96	.42	.83	1.10	1.93	.62
		Average of all cooked 3 and 5 hours . . . . .	97.11	2.89	.33	.85	1.09	1.94	.62
		Maximum . . . . .	97.98	3.43	.96	1.07	1.37	2.44	.79
		Minimum . . . . .	96.57	2.02	.15	.60	.74	1.39	.46

TABLE 133.—*Composition of clear, filtered broth. (Results of experiments made in 1903-1904)*—Continued.

Cook- ing ex- per- iment No.	Lab- ora- tory No.	Kind of meat.	Percentage composition of the clear, filtered broth. (Water-free substance.)				
			Pro- teid.	Organic extractives.			Ash.
				Nitrog- enous.	Non- nitrog- enous.	Total.	
			<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
109	1642	Beef, round, 1-inch cubes.....	5.34	30.86	40.65	71.51	23.44
137	1754	Beef, round, 2-inch cubes.....	6.62	31.99	39.34	71.32	22.66
		Average.....	5.98	31.43	40.00	71.42	22.75
139	1756	Beef, round, browned, 2-inch cubes.....	6.23	32.23	39.19	71.43	22.35
		Average Nos. 1642, 1754, 1756.....	6.06	31.69	39.73	71.42	22.62
136	1746	Beef, round, browned, 2-inch cubes.....	7.86	30.36	39.64	70.00	21.79
145	1772	Beef, round, 2-inch cubes.....	7.45	32.89	36.84	69.74	22.81
154	1783	.....do.....					
		Average Nos. 1772 and 1783.....	7.66	31.63	38.24	69.87	22.30
108	1641	Beef, round, 1-inch cubes.....	6.41	31.20	39.94	71.14	22.16
134	1744	Beef, round, 2-inch cubes.....	9.49	29.49	40.34	69.83	20.68
		Average.....	7.95	30.35	40.14	70.49	21.22
144	1773	Beef, round, 1 piece.....	7.43	33.17	36.63	69.80	22.77
153	1784	.....do.....	6.66	32.17	38.26	70.43	22.61
		Average.....	7.20	32.67	37.45	70.12	22.69
		Average Nos. 1641, 1744, 1773, and 1784.....	7.57	31.51	38.79	70.30	22.06
138	1755	Beef, round, 2-inch cubes.....	8.97	31.38	37.24	68.62	22.07
140	1757	Beef, round, browned, 2-inch cubes.....	8.68	30.90	37.85	68.75	22.22
		Average.....	8.82	31.14	37.55	68.69	22.15
133	1743	Beef, round, 2-inch cubes.....	11.74	29.87	37.58	67.45	20.80
135	1745	Beef, round, browned, 2-inch cubes.....	11.89	29.37	38.11	67.48	20.28
		Average.....	11.82	29.62	37.85	67.47	20.54
		Average of all cooked 3 hours.....	8.08	31.22	38.59	69.81	22.00
113	1646	Beef, round, 2-inch cubes.....	7.69	29.81	38.78	68.59	24.04
112	1645	.....do.....	4.72	31.76	40.57	72.33	23.27
116	1654	Veal, leg, 1-inch cubes.....	13.95	25.85	39.12	64.97	21.43
118	1658	.....do.....	16.03	27.87	33.80	61.67	22.30
		Average Nos. 1654 and 1658.....	14.99	26.86	36.46	63.32	21.87
		Average Nos. 1645, 1654, and 1658.....	11.57	28.49	37.83	66.32	22.33
111	1644	Beef, round, 2-inch cubes.....	7.17	30.29	39.41	69.71	23.13
131	1720	Beef, round, 1-inch cubes.....	8.92	29.54	41.85	71.38	19.69
		Average.....	8.05	29.92	40.63	70.55	21.41
121	1665	Beef, neck, 2-inch cubes.....					23.21
123	1673	Beef, rump, 1-inch cubes.....	13.93	26.64	37.70	64.34	21.72
125	1703	.....do.....	12.11	30.45	36.33	66.78	21.11
		Average Nos. 1673 and 1703.....	13.02	28.55	37.02	65.56	21.42
122	1669	Beef, flank, 2-inch cubes.....	25.90	23.91	31.47	55.37	18.73
115	1653	Veal, leg, 1-inch cubes.....	9.38	29.51	39.24	68.75	21.88
117	1664	.....do.....	17.73	27.66	32.63	60.29	21.99
		Average Nos. 1653 and 1664.....	13.56	28.59	35.94	64.52	21.94
		Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	13.59	28.29	36.95	65.23	21.44

TABLE 133.—*Composition of clear, filtered broth. (Results of experiments made in 1903-1904)*—Continued.

Cooking experiment No.	Laboratory No.	Kind of meat.	Percentage composition of the clear, filtered broth. (Water-free substance.)				
			Proteid.	Organic extractives.			Ash.
				Nitrogenous.	Non-nitrogenous.	Total.	
			<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
107	1639	Beef, round, 1-inch cubes.....	10.73	28.07	39.75	67.82	21.14
110	1643	Beef, round, ¾-inch cubes.....	13.49	29.28	36.18	65.46	21.05
132	1721	Beef, round, 1-inch cubes.....	17.99	26.25	38.05	64.30	17.70
		Average.....	14.07	27.87	37.99	65.86	19.96
126	1704	Beef, rump, 1-inch cubes.....	28.21	24.14	30.41	54.55	16.93
114	1652	Veal, leg, 1-inch cubes.....	20.52	25.00	35.82	60.82	19.03
		Average Nos. 1639, 1643, 1652, 1704, and 1721.....	18.19	26.55	36.04	62.59	19.17
		Average of all cooked 5 hours.....	14.28	27.88	36.95	64.82	21.08
		Average of all cooked 3 and 5 hours.....	11.50	29.38	37.68	67.06	21.48
		Maximum.....	28.21	33.17	41.85	72.33	24.04
		Minimum.....	4.72	23.91	30.41	54.55	16.93

By referring to Table 132, page 207, it will be seen that on an average the 73 samples of clear, filtered meat broths, when calculated on the basis of 100 grams of meat per 100 grams of broth, or 1 pound of meat per 1.04 pints of complete broth, had the following percentage composition: Water 98.03, total solid matter 1.97, proteid 0.17, nitrogenous extractives 0.59, nonnitrogenous extractives 0.74, total organic extractives 1.34, fat 0.0, and ash 0.46 per cent.

Comparing the data here given for the clear, filtered broths with the results obtained for the complete broths, it is evident that the former contain much less total solid matter than the latter. The total dry substance in the clear, filtered broths varied from 0.73 to 2.95 per cent, the average being 1.97 per cent, while the total solid material in the complete broths ranged from 1.12 per cent to 10.27 per cent, averaging 3.36 per cent. In other words, the inorganic and organic material dissolved in the clear, filtered broths is equal upon the average to 59 per cent of the total solid matter of the complete broths.

The smallest quantity of solid matter, 0.73 per cent, was found in sample No. 1094, from cooking experiment No. 27, in which a large piece of very fat beef, known as "plate boil," was cooked at 100° C. for ten minutes and then at 80 to 85° C. for two hours. It was composed of 0.05 per cent proteid, 0.18 per cent nitrogenous extractives, 0.34 per cent nonnitrogenous extractives, 0.52 per cent total organic extractives, and 0.16 per cent ash, or, on a water-free basis, 6.85 per cent proteid, 24.66 per cent nitrogenous extractives, 46.57 per cent nonnitrogenous extractives, 71.23 per cent total organic extractives, and 21.92 per cent ash.



The largest quantity of solid matter, 2.95 per cent, in the clear broths was noted in sample No. 779b, from cooking experiment No. 21, in which a small piece of lean beef round was cooked at 100° C. for ten minutes and then at 80 to 85° C. for two hours. It consisted of 0.43 per cent proteid, 0.80 per cent nitrogenous extractives, 1.04 per cent nonnitrogenous extractives, 1.84 per cent total organic extractives, and 0.68 per cent ash, or, on a water-free basis, 14.58 per cent proteid, 27.12 per cent nitrogenous extractives, 35.25 per cent non-nitrogenous extractives, 62.37 per cent total organic extractives, and 23.05 per cent ash.

In discussing (see p. 200) the composition of the complete broths it was stated that the richness of the broths, as measured by the total solids which they contain, seems to depend largely upon the sizes of the pieces of meat used, and in order to show that this conclusion was justified the average results of the analyses of several series of complete broths were considered. It will be of interest to study the results obtained in the analysis of the clear, filtered broths from the same series of experiments to see whether or not they lead to the same conclusion.

The average amount of solid matter in four clear filtered broths (Nos. 1370, 1371, 1382, and 1383) prepared from lean beef round, cut into one-half inch cubes, cooked for ten minutes at 100° C., and then for two hours at 80 to 85° C., was equal to 2.70 per cent of the weight of the meat taken, and was made up of 0.11 per cent of proteid, 0.88 per cent of nitrogenous extractives, 1.06 per cent of nonnitrogenous extractives, 1.94 per cent of total organic extractives, and 0.65 per cent of ash, or, on a water-free basis, 3.97 per cent proteid, 32.67 per cent nitrogenous extractives, 39.42 per cent nonnitrogenous extractives, 72.09 per cent total organic extractives, and 23.94 per cent ash.

The average quantity of total solid material in eleven clear broths which were made by cooking small pieces of lean beef round (about 1.5 pounds) for ten minutes at 100° C. and then for two hours at 80 to 85° C. was equal to 2.65 per cent of the weight of the original complete broth. The solid constituents of these eleven clear broths consisted of 0.24 per cent proteid, 0.77 per cent nitrogenous extractives, 1.00 per cent nonnitrogenous extractives, 1.77 per cent total organic extractives, and 0.64 per cent ash, or, on a water-free basis, 8.93 per cent proteid, 28.94 per cent nitrogenous extractives, 37.65 per cent nonnitrogenous extractives, 66.58 per cent total organic extractives, and 24.49 per cent ash.

The average amount of total solid material in eight clear broths, Nos. 895, 1027, 1097, 1205, 1211, 1242, 1379, and 1387, prepared by cooking a large piece of lean beef round (about 4.5 pounds) for ten minutes at 100° C. and then for two hours at 80 to 85° C. was equal to 1.90 per cent of the weight of the entire broths, and was made up of 0.12 per



cent of proteid, 0.63 per cent of nitrogenous extractives, 0.71 per cent of nonnitrogenous extractives, 1.34 per cent of total organic extractives, and 0.45 per cent ash, or, on a water-free basis, 6.50 per cent proteid, 32.94 per cent nitrogenous extractives, 36.84 per cent nonnitrogenous extractives, 69.78 per cent total organic extractives, and 23.73 per cent ash.

It is evident from these data and those on page 200 that the size of the piece of meat cooked in hot water influences the composition of the complete broth more than it does the clear broth. In other words, there are decidedly greater differences in the amounts of total solids in the complete broths than in the case of the clear broths, the difference being due mainly to variations in proteid and fat. That is to say, when meats cut into small cubes are cooked in hot water, more fat and coagulated proteid pass into the broth in insoluble form than is the case when the meats are cooked in single or large pieces. There is also a slightly greater quantity of organic extractives and ash in the broths in the former case than in the latter.

Table 132, pages 207-209, gives the chemical composition of the total solid matter contained in these clear meat broths. On a water-free basis the average values for 73 samples were: Proteid, 8.96 per cent; nitrogenous extractives, 29.42 per cent; nonnitrogenous extractives, 38.44 per cent; total organic extractives, 67.86 per cent, and ash, 23.18 per cent. The corresponding data for the same complete broths were as follows: Proteid, 11.54 per cent; nitrogenous extractives, 19.51 per cent; nonnitrogenous extractives, 24.91 per cent; total organic extractives, 44.42 per cent; fat, 28.68 per cent, and ash 15.38 per cent. The solid residues obtained from the clear broths differ from those obtained from the complete broths, in that they contain no fat, and it follows that the proportions of the other constituents, especially organic extractives and ash, are higher.

Although complete meat broths do not actually contain much real nutritive material, namely, proteid and fat, they do contain considerably more of these nutrients than the clear broths. In other words, the process of clarifying (filtering or straining) broths removes a considerable proportion of the true nutritive material present and does not alter the amount of the less valuable constituents.

As regards flavor, it is evident that since the amount of total extractives is not materially reduced, there will be little difference in flavor between complete and clear, filtered broths provided the fat content in both cases is the same.

In the experiments here considered, however, the complete broths contained considerable fat, which was removed in the process of filtration. Since it is well known that meat fat possesses a fairly distinctive flavor, its removal would tend to modify the flavor of the broth to a greater or less degree. The same conditions would also

obtain in the household. If the complete broth contained but little fat, its flavor would be largely due to the extractives, and, consequently, little modified by straining. So, too, if the broths were filtered so that the fat was melted, and so passed through the strainer, but little change of flavor would be expected. On the other hand, if the original fat content was relatively large, and the fat practically all removed by the filtration, the flavor would doubtless be modified accordingly. When the data in Table 133 regarding the clear, filtered broth from small pieces of meat cooked for fairly long periods are considered, it will be seen that, taken either individually or as a whole, the results are noticeably higher—that is, the broths are richer than those obtained from meats cooked in large pieces for short periods.

The average percentage composition of 14 clear broths prepared by cooking meats for three hours was: Water 97.21, total solid matter 2.79, proteid 0.23, nitrogenous extractives 0.87, nonnitrogenous extractives 1.08, total organic extractives 1.95, and ash 0.61 per cent. The average percentage composition of 17 clear broths from meats cooked for five hours was: Water 97.04, total solid matter 2.96, proteid 0.42, nitrogenous extractives 0.83, nonnitrogenous extractives, 1.10; total organic extractives, 1.93, and ash 0.62. The more extended boiling perceptibly increased the proteid content of the broths, though the differences are less marked than in the case of the complete broths.

The differences pointed out may also be noted when the data are considered on a water-free basis. (See Table 133.)

#### NITROGENOUS CONSTITUENTS OF BROTHS.

Since the available information regarding the nature of the proteid and nonproteid substances occurring in meats is not very considerable, it necessarily follows that the character of these constituents in broth is also not very well understood. In view of this fact it seemed desirable to undertake at least a preliminary study of these substances as they occur in broths in connection with the similar studies of raw and cooked meats.<sup>a</sup>

The details of the methods used have already been described, pages 13–15. The results obtained are given in a condensed form in Tables 134 to 136, inclusive.

<sup>a</sup> See this bulletin, pp. 141–169. See also Jour. Amer. Chem. Soc., 26 (1904), p. 1086, and U. S. Dept. Agr., Bureau of Chemistry Bul. 81, p. 110. See also summary on p. 229.

TABLE 134.—*Nitrogen records of the clear, filtered broth (expressed in percentage of meat taken for cooking).*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Total nitrogen in meat.	Total nitrogen in broth.	Nitrogen coagulated by heat.	Nitrogen precipitated by ZnSO <sub>4</sub> (albumose).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by (NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> .
				At beginning.	During cooking.							
				°C.	°C.	Hrs.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1642	1640	109	Beef, round .....	Cold.	85	3	5.770	0.3550	0.0008	0.0271	0.0279	
1754	1753	137	do. ....	Cold.	85	3	5.884	.3038	0	.0277	.0277	
			Average .....	Cold.	85	3	5.827	.3294	.0004	.0274	.0278	
1756	1753	139	Beef, round (browned).	Cold.	85	3	5.495	.3064	0	.0273	.0273	
			Average Nos. 1642, 1754, and 1756..	Cold.	85	3	5.716	.3217	.0003	.0274	.0276	
1746	1741	136	Beef, round (browned).	85	85	3	5.696	.3017	.0008	.0333	.0341	
1769	1764	145	Beef, round .....	85	85	3	5.810	.2671	.0021	.0244	.0265	
1780	1775	154	do. ....	85	85	3	6.040	.2547	.0038	.0163	.0201	
			Average Nos. 1769 and 1780 .....	85	85	3	5.925	.2609	.0030	.0204	.0233	
			Average Nos. 1746, 1769, and 1780..	85	85	3	5.849	.2745	.0022	.0247	.0269	
1641	1640	108	Beef, round .....	100	85	3	5.910	.3758	0	.0349	.0349	
1744	1741	134	do. ....	100	85	3	5.862	.3224	.0006	.0437	.0443	
1768	1764	144	do. ....	100	85	3	5.309	.2388	.0027	.0206	.0233	
1779	1775	153	do. ....	100	85	3	6.013	.2613	.0055	.0204	.0259	
			Average .....	100	85	3	5.774	.2996	.0022	.0299	.0321	
1755	1753	138	Beef, round .....	Cold.	100	3	5.857	.3267	0	.0415	.0415	
1757	1753	140	Beef, round (browned).	Cold.	100	3	5.855	.3253	0	.0393	.0393	
			Average .....	Cold.	100	3	5.856	.3260	0	.0404	.0404	
1743	1741	133	Beef, round .....	100	100	3	5.834	.3403	.0012	.0548	.0560	
1745	1741	135	Beef, round (browned).	100	100	3	5.556	.3156	.0006	.0523	.0529	
			Average .....	100	100	3	5.695	.3280	.0009	.0536	.0545	
			Average of all cooked 3 hours .....			3	5.785	.3068	.0013	.0331	.0344	
1646	1647	113	Beef, round .....	Cold.	65	5	5.240	.3312	.0116	.0225	.0341	0.0030
1645	1647	112	do. ....	Cold.	85	5	5.420	.3410	.0011	.0198	.0209	.0025
1654	1656	116	Veal, leg .....	Cold.	85	5	5.070	.3072	.0018	.0498	.0516	.0132
1658	1662	118	do. ....	Cold.	85	5	4.800	.3260	.0017	.0685	.0702	.0023
			Average Nos. 1654 and 1658 .....	Cold.	85	5	4.935	.3166	.0018	.0592	.0609	.0078
			Average Nos. 1645, 1654, and 1658..	Cold.	85	5	5.097	.3247	.0015	.0460	.0476	.0060
1644	1647	111	Beef, round .....	100	85	5	5.590	.3289	.0015	.0319	.0334	.0018
1720	1722	131	do. ....	100	85	5	5.309	.3500	0	.0460	.0460	
			Average .....	100	85	5	5.450	.3395	.0008	.0390	.0397	.0018
1665	1668	121	Beef, neck .....	100	85	5	5.039	.2238	.0024			.0028
1673	1676	123	Beef, rump .....	100	85	5	3.245	.2453	.0008	.0490	.0498	.0017
1703	1705	125	do. ....	100	85	5	4.433	.3307	.0040	.0501	.0541	
			Average Nos. 1673 and 1703 .....	100	85	5	3.839	.2880	.0024	.0496	.0520	.0017

TABLE 134.—*Nitrogen records of the clear, filtered broth (expressed in percentage of meat taken for cooking)*—Continued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Total nitrogen in meat.	Total nitrogen in broth.	Nitrogen coagulated by heat.	Nitrogen precipitated by ZnSO <sub>4</sub> (albumose).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromin in filtrate from ZnSO <sub>4</sub> .
				At beginning.	During cooking.							
				°C.	°C.	Hrs.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1669	1672	122	Beef, flank .....	100	85	5	3.210	0.2777	0.0019	0.0942	0.0061	0.0018
1653	1656	115	Veal, leg .....	100	85	5	5.360	.3152	.0044	.0230	.0274	.0155
1664	1662	117	do. ....	100	85	5	4.900	.3292	.0017	.0754	.0771	.0029
			Average Nos. 1653 and 1664 .....	100	85	5	5.130	.3222	.0031	.0492	.0523	.0092
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720 .....	100	85	5	4.636	.3001	.0021	.0528	.0548	.0044
1639	1637	107	Beef, round .....	100	100	5	5.640	.3392	.0017	.0530	.0547	.....
1643	1647	110	do. ....	100	100	5	5.370	.3458	.0035	.0590	.0625	.0030
1721	1722	132	do. ....	100	100	5	5.324	.3785	0	.0962	.0962	.....
			Average .....	100	100	5	5.445	.3545	.0017	.0694	.0711	.0030
1704	1705	126	Beef, rump .....	100	100	5	4.583	.3787	.0035	.1364	.1399	.....
1652	1656	114	Veal, leg .....	100	100	5	5.310	.3013	.0017	.0706	.0723	.0148
			Average Nos. 1639, 1643, 1652, 1704, and 1721 .....	100	100	5	5.246	.3487	.0021	.0830	.0851	.0089
			Average of all cooked 5 hours .....	.....	.....	5	4.932	.3206	.0026	.0591	.0616	.0054
			Average of all cooked 3 or 5 hours .....	.....	.....	.....	5.317	.3144	.0020	a. 0470	a. 0489	b. 0054

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Proteid nitrogen in broth.	Nonproteid nitrogen in broth.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen precipitated by alcohol.	Nitrogen as ammonia.
				P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
1642	1640	109	Beef, round .....	0.0279	0.3271	.....	0.0272	0.1144	.....	.....	.....	.....
1754	1753	137	do. ....	.0277	.2761	.....	0.0300	.0284	.0370	0.0511	.....	0.0137
			Average .....	.0278	.3016	.....	.0300	.0278	.0757	.0511	.....	.0137
1756	1753	139	Beef, round (browned).	.0273	.2791	.....	.0285	.0278	.0352	.0479	.....	.0135
			Average Nos. 1642, 1754, and 1756 .....	.0276	.2941	.....	.0293	.0278	.0622	.0495	.....	.0136
1746	1741	136	Beef, round (browned).	.0341	.2676	.....	.0282	.0318	.0339	.0167	.....	.0117
1769	1764	145	Beef, round .....	.0265	.2406	.....	.0215	.0281	.0297	.0357	.....	.0115
1780	1775	154	do. ....	.0201	.2346	.....	.0226	.0127	.0201	.0362	.....	.0126
			Average Nos. 1769 and 1780 .....	.0233	.2376	.....	.0221	.0204	.0249	.0360	.....	.0121
			Average Nos. 1746, 1769, and 1780 .....	.0269	.2476	.....	.0241	.0242	.0279	.0295	.....	.0119
1641	1640	108	Beef, round .....	.0349	.3409	.....	.....	.0390	.1251	.....	.....	.....
1744	1741	134	do. ....	.0443	.2781	.....	.0349	.0390	.0553	.0181	.....	.0129
1768	1764	144	do. ....	.0233	.2155	.....	.0189	.0200	.0272	.0330	.....	.0094
1779	1775	153	do. ....	.0259	.2354	.....	.0234	.0110	.0202	.0338	.....	.0097
			Average .....	.0321	.2675	.....	.0257	.0273	.0570	.0283	.....	.0107

a Average of 30 analyses.

b Average of 12 analyses.



TABLE 134.—*Nitrogen records of the clear, filtered broth (expressed in percentage of meat taken for cooking)—Continued.*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Protein in broth.	Nonprotein nitrogen in broth.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen precipitated by alcohol.	Nitrogen as ammonia.
1755	1753	138	Beef, round.....	<i>P. ct.</i> 0.0415	<i>P. ct.</i> 0.2832	<i>P. ct.</i> .....	<i>P. ct.</i> 0.0425	<i>P. ct.</i> 0.0421	<i>P. ct.</i> 0.0426	<i>P. ct.</i> 0.0532	<i>P. ct.</i> .....	<i>P. ct.</i> 0.0181
1757	1753	140	Beef, round (browned).....	0.0393	0.2860	.....	0.0364	0.0315	0.0403	0.0482	.....	0.0176
			Average.....	0.0404	0.2856	.....	0.0395	0.0368	0.0415	0.0507	.....	0.0179
1743	1741	133	Beef, round.....	0.0560	0.2843	.....	0.0276	0.0879	0.0266	0.0238	.....	0.0156
1745	1741	135	Beef, round (browned).....	0.0529	0.2627	.....	0.0309	0.0540	0.0545	0.0278	.....	0.0159
			Average.....	0.0545	0.2735	.....	0.0293	0.0710	0.0406	0.0258	.....	0.0158
			Average of all cooked 3 hours.....	0.0344	0.2724	.....	0.0288	0.0343	0.0473	0.0355	.....	0.0135
1646	1647	113	Beef, round.....	0.0371	0.2941	.....	.....	0.0385	0.0437	.....	.....	0.0024
1645	1647	112	do.....	0.0234	0.3176	.....	.....	0.0360	0.0385	.....	.....	0.0043
1654	1656	116	Veal, leg.....	0.0648	0.2424	0.0312	0.0196	0.0366	0.0353	.....	.....	0.0121
1658	1662	118	do.....	0.0725	0.2535	0.0674	0.0246	0.0822	0.0668	.....	.....	0.0142
			Average Nos. 1654 and 1658.....	0.0687	0.2480	0.0493	0.0221	0.0594	0.0511	.....	.....	0.0132
			Average Nos. 1645, 1654, and 1658.....	0.0536	0.2712	0.0493	0.0221	0.0516	0.0469	.....	.....	0.0102
1644	1647	111	Beef, round.....	0.0352	0.2937	.....	.....	0.0355	0.0612	.....	.....	0.0061
1720	1722	131	do.....	0.0460	0.3040	.....	0.0483	0.0477	0.0540	0.0434	0.1149	0.0117
			Average.....	0.0406	0.2989	.....	0.0483	0.0416	0.0576	.....	.....	0.0089
1665	1668	121	Beef, neck.....	.....	.....	0.0248	0.0186	0.0301	0.0305	.....	.....	0.0185
1673	1676	123	Beef, rump.....	0.0515	0.1938	0.0706	0.0410	0.0291	0.0338	.....	.....	0.0135
1703	1705	125	do.....	0.0541	0.2766	.....	0.0574	0.0519	0.0589	0.0327	0.0926	0.0197
			Average Nos. 1673 and 1703.....	0.0528	0.2352	0.0706	0.0492	0.0405	0.0464	.....	.....	0.0166
1669	1672	122	Beef, flank.....	0.0979	0.1798	0.0803	0.0436	0.1019	0.0912	.....	.....	0.0195
1653	1656	115	Veal, leg.....	0.0429	0.2723	0.0182	0.0127	0.0203	0.0454	.....	.....	0.0143
1664	1662	117	do.....	0.0800	0.2492	0.0661	0.0246	0.0828	0.0716	.....	.....	0.0140
			Average Nos. 1653 and 1664.....	0.0615	0.2608	0.0422	0.0187	0.0516	0.0585	.....	.....	0.0142
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	0.0582	0.2528	0.0520	0.0352	0.0499	0.0570	.....	.....	0.0147
1639	1637	107	Beef, round.....	0.0547	0.2845	.....	.....	0.0799	0.1765	.....	.....	.....
1643	1647	110	do.....	0.0655	0.2803	.....	.....	0.0725	0.0950	.....	.....	0.0073
1721	1722	132	do.....	0.0962	0.2823	.....	0.0749	0.0924	0.0928	0.0441	0.1624	0.0177
			Average.....	0.0721	0.2824	.....	0.0749	0.0816	0.1214	.....	.....	0.0125
1704	1705	126	Beef, rump.....	0.1399	0.2388	.....	0.0875	0.1372	0.1218	0.0673	0.1812	0.0195
1652	1656	114	Veal, leg.....	0.0871	0.2142	0.0513	0.0391	0.0702	0.0765	.....	.....	0.0137
			Average Nos. 1639, 1643, 1652, 1704, and 1721.....	0.0887	0.2600	0.0513	0.0672	0.0904	0.1125	.....	.....	0.0146
			Average of all cooked 5 hours.....	0.0656	0.2611	0.0512	0.0410	0.0614	0.0708	.....	.....	0.0131
			Average of all cooked 3 or 5 hours.....	<i>a.</i> 0.0510	<i>a.</i> 0.2664	<i>b.</i> 0.0512	<i>c.</i> 0.0349	0.0492	0.0602	<i>d.</i> 0.0384	<i>e.</i> 0.1378	<i>f.</i> 0.1333

*a* Average of 30 analyses.*b* Average of 8 analyses.*c* Average of 13 analyses.*d* Average of 16 analyses.*e* Average of 4 analyses.*f* Average of 29 analyses.



TABLE 135.—*Nitrogen records of the clear, filtered broth (expressed in percentage of total nitrogen in uncooked meat).*

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Total nitrogen in uncooked meat.		Total nitrogen in broth.	Nitrogen coagulated by heat.	Nitrogen precipitated by ZnSO <sub>4</sub> (albumose).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromine and filtrate from ZnSO <sub>4</sub> .
				At beginning.	During cooking.								
				°C.	°C.	Hrs.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
1642	1640	109	Beef, round .....	Cold.	85	3	100	9.92	0.02	0.76	0.78		
1754	1753	137	.....do.....	Cold.	85	3	100	8.85	0	.81	.81		
			Average.....	Cold.	85	3	100	9.39	.01	.79	.80		
1756	1753	139	Beef, round (browned).	Cold.	85	3	100	8.93	0	.80	.80		
			Average Nos.1642, 1754, and 1756 ..	Cold.	85	3	100	9.23	.01	.79	.80		
1746	1741	136	Beef, round (browned).	85	85	3	100	8.81	.02	.97	1.00		
1769	1764	145	Beef, round .....	85	85	3	100	8.22	.06	.75	.82		
1780	1775	154	.....do.....	85	85	3	100	7.61	.11	.49	.60		
			Average Nos.1769 and 1780.....	85	85	3	100	7.92	.09	.62	.71		
			Average Nos.1746, 1769, and 1780....	85	85	3	100	8.21	.06	.74	.81		
1641	1640	108	Beef, round .....	100	85	3	100	10.50	0	.97	.97		
1744	1741	134	.....do.....	100	85	3	100	9.42	.02	1.28	1.29		
1768	1764	144	.....do.....	100	85	3	100	7.35	.08	.63	.72		
1779	1775	153	.....do.....	100	85	3	100	7.80	.16	.61	.77		
			Average.....	100	85	3	100	8.77	.07	.87	.94		
1755	1753	138	Beef, round .....	Cold.	100	3	100	9.52	0	1.21	1.21		
1757	1753	140	Beef, round (browned).	Cold.	100	3	100	9.47	0	1.14	1.14		
			Average.....	Cold.	100	3	100	9.50	0	1.18	1.18		
1743	1741	133	Beef, round .....	100	100	3	100	9.94	.04	1.60	1.64		
1745	1741	135	Beef, round (browned).	100	100	3	100	9.22	.02	1.53	1.55		
			Average.....	100	100	3	100	9.58	.03	1.57	1.60		
			Average of all cooked 3 hours.					8.97	.04	.97	1.01		
1646	1647	113	Beef, round .....	Cold.	65	5	100	9.89	.35	.67	1.02	0.09	
1645	1647	112	.....do.....	Cold.	85	5	100	10.18	.03	.59	.62	.07	
1654	1656	116	Veal, leg .....	Cold.	85	5	100	8.85	.05	1.44	1.49	.38	
1658	1662	118	.....do.....	Cold.	85	5	100	10.09	.05	2.12	2.17	.07	
			Average Nos.1654 and 1658.....	Cold.	85	5	100	9.47	.05	1.78	1.83	.23	
			Average Nos.1645, 1654, and 1658....	Cold.	85	5	100	9.71	.04	1.38	1.43	.17	
1644	1647	111	Beef, round .....	100	85	5	100	9.82	.04	.95	1.00	.05	
1720	1722	131	.....do.....	100	85	5	100	10.32	0	1.36	1.36		
			Average.....	100	85	5	100	10.07	.02	1.16	1.18		
1665	1668	121	Beef, neck .....	100	85	5	100	7.22	.08			.09	
1673	1676	123	Beef, rump .....	100	85	5	100	10.22	.03	2.04	2.08	.07	
1703	1705	125	.....do.....	100	85	5	100	11.67	.14	1.77	1.91		
			Average Nos.1673 and 1703.....	100	85	5	100	10.95	.09	1.91	2.00		

TABLE 135.—*Nitrogen records of the clear, filtered broth (expressed in percentage of total nitrogen in uncooked meat)*—Continued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Total nitrogen in uncooked meat.	Total nitrogen in broth.	Nitrogen coagulated by heat.	Nitrogen precipitated by $ZnSO_4$ (albumose).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromin in filtrate from $ZnSO_4$ .
				At beginning.	During cooking.							
				°C.	°C.	Hrs.	P. ct.	P. ct.	Per ct.	Per ct.	Per ct.	Per ct.
1669	1672	122	Beef, flank.....	100	85	5	100	11.20	0.08	3.80	3.88	0.07
1653	1656	115	Veal, leg.....	100	85	5	100	9.08	.13	.66	.79	.45
1664	1662	117	.....do.....	100	85	5	100	10.19	.05	2.33	2.39	.09
			Average Nos.1653 and 1664.....	100	85	5	100	9.64	.09	1.50	1.59	.27
			Average Nos.1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	100	85	5	100	9.97	.07	1.85	1.92	.....
1639	1637	107	Beef, round.....	100	100	5	100	10.01	.05	1.56	1.61	.....
1643	1647	110	.....do.....	100	100	5	100	10.32	.10	1.76	1.87	.09
1721	1722	132	.....do.....	100	100	5	100	11.16	0	2.84	2.84	.....
			Average.....	100	100	5	100	10.50	.05	2.05	2.11	.....
1704	1705	126	Beef, rump.....	100	100	5	100	13.36	.12	4.81	4.93	.....
1652	1656	114	Veal, leg.....	100	100	5	100	8.68	.05	2.03	2.08	.43
			Average Nos.1639, 1643, 1652, 1704, and 1721.....	100	100	5	100	10.71	.06	2.60	2.67	.....
			Average of all cooked 5 hours.....	.....	.....	.....	100	10.14	.08	1.92	2.01	a.16
			Average of all cooked 3 or 5 hours.....	.....	.....	.....	100	9.61	.06	1.48	b 1.54	.....

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Proteid nitrogen in broth.		Nonproteid nitrogen in broth.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen precipitated by alcohol.	Nitrogen as ammonia.
				P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
1642	1640	109	Beef, round.....	0.78	9.14	.....	.....	0.76	3.20	.....	.....	.....	.....
1754	1753	137	.....do.....	.81	8.04	.....	.....	.83	1.08	1.49	.....	.....	0.40
			Average.....	.80	8.59	.....	.....	.80	2.14	.....	.....	.....	.....
1756	1753	139	Beef, round (browned). Average Nos.1642, 1754, and 1756...	.80	8.13	.....	.83	.81	1.03	1.40	.....	.....	.39
			.....do.....	.80	8.44	.....	.85	.80	1.77	1.45	.....	.....	.40
1746	1741	136	Beef, round (browned). Beef, round.....	1.00	7.81	.....	.82	.93	.99	.49	.....	.....	.34
1769	1764	145	.....do.....	.82	7.40	.....	.66	.86	.91	1.10	.....	.....	.35
1780	1775	154	.....do.....	.60	7.01	.....	.67	.38	.60	1.08	.....	.....	.38
			Average Nos.1769 and 1780.....	.71	7.21	.....	.67	.62	.76	1.09	.....	.....	.37
			Average Nos.1746, 1769, and 1780...	.81	7.41	.....	.72	.72	.83	.89	.....	.....	.36
1641	1640	108	Beef, round.....	.97	9.52	.....	.....	1.09	3.49	.....	.....	.....	.....
1744	1741	134	.....do.....	1.29	8.12	.....	1.02	1.14	1.62	.53	.....	.....	.38
1768	1764	144	.....do.....	.72	6.63	.....	.58	.62	.84	1.02	.....	.....	.29
1779	1775	153	.....do.....	.77	7.03	.....	.70	.33	.60	1.01	.....	.....	.29
			Average.....	.94	7.83	.....	.77	.80	1.64	.85	.....	.....	.32

<sup>b</sup> Average of 12 analyses.<sup>a</sup> Average of 30 analyses.

TABLE 135.—*Nitrogen records of the clear, filtered broth (expressed in percentage of total nitrogen in uncooked meat)*—Continued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Protein nitrogen in broth.	Nonprotein nitrogen in broth.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen precipitated by alcohol.	Nitrogen as ammonia.
				<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
1755	1753	138	Beef, round.....	1.21	8.31	.....	1.24	1.23	1.24	1.55	.....	0.53
1757	1753	140	Beef, round (browned).....	1.14	8.33	.....	1.06	.92	1.17	1.40	.....	.51
			Average.....	1.18	8.32	.....	1.15	1.08	1.21	1.48	.....	.52
1743	1741	133	Beef, round.....	1.64	8.30	.....	.81	2.57	.78	.69	.....	.46
1745	1741	135	Beef, round (browned).....	1.55	7.67	.....	.90	1.58	1.59	.82	.....	.47
			Average.....	1.60	7.99	.....	.86	2.08	1.19	.76	.....	.47
			Average of all cooked 3 hours.....	1.01	7.97	.....	.85	1.01	1.37	1.08	.....	.40
1646	1647	113	Beef, round.....	1.11	8.78	.....	.....	1.15	1.30	.....	.....	.07
1645	1647	112	.....do.....	.70	9.48	.....	.....	1.07	1.15	.....	.....	.13
1654	1656	116	Veal, leg.....	1.87	6.98	0.90	.56	1.05	1.02	.....	.....	.35
1658	1662	118	.....do.....	2.24	7.85	2.09	.76	2.54	2.07	.....	.....	.44
			Average Nos.1654 and 1658.....	2.06	7.42	1.50	.66	1.80	1.55	.....	.....	.40
			Average Nos.1645, 1654, and 1658.....	1.60	8.10	.....	.....	1.55	1.41	.....	.....	.31
1644	1647	111	Beef, round.....	1.05	8.77	.....	.....	1.06	1.83	.....	.....	.18
1720	1722	131	.....do.....	1.36	8.96	.....	1.42	1.41	1.59	1.28	3.39	.34
			Average.....	1.21	8.87	.....	.....	1.24	1.71	.....	.....	.26
1665	1668	121	Beef, neck.....	.....	.....	.80	.60	.97	1.28	.....	.....	.60
1673	1676	123	Beef, rump.....	2.15	8.07	2.94	1.71	1.21	1.41	.....	.....	.56
1703	1705	125	.....do.....	1.91	9.76	.....	2.02	1.83	2.08	1.15	3.27	.69
			Average Nos.1673 and 1703.....	2.03	8.92	.....	1.87	1.52	1.75	.....	.....	.63
1669	1672	122	Beef, flank.....	3.95	7.25	3.24	1.76	4.11	3.68	.....	.....	.79
1653	1656	115	Veal, leg.....	1.24	7.85	.52	.37	.59	1.31	.....	.....	.40
1664	1662	117	.....do.....	2.48	7.71	2.05	.76	2.56	2.22	.....	.....	.43
			Average Nos.1653 and 1664.....	1.86	7.78	1.29	.57	1.58	1.77	.....	.....	.42
			Average Nos.1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	2.02	8.34	1.91	1.24	1.72	1.93	.....	.....	.50
1639	1637	107	Beef, round.....	1.61	8.39	.....	.....	2.36	5.21	.....	.....	.....
1643	1647	110	.....do.....	1.96	8.37	.....	.....	2.16	2.84	.....	.....	.22
1721	1722	132	.....do.....	2.84	8.32	.....	2.21	2.72	2.74	1.30	4.79	.52
			Average.....	2.14	8.36	.....	.....	2.41	3.60	.....	.....	.37
1704	1705	126	Beef, rump.....	4.93	8.43	.....	3.09	4.84	4.30	2.38	6.39	.69
1652	1656	114	Veal, leg.....	2.51	6.17	1.48	1.13	2.02	2.20	.....	.....	.39
			Average Nos.1639, 1643, 1652, 1704, and 1721.....	2.77	7.94	.....	2.14	2.82	3.46	.....	.....	.46
			Average of all cooked 5 hours.....	2.12	8.20	a 1.75	1.37	1.98	2.27	.....	.....	.43
			Average of all cooked 3 or 5 hours.....	b 1.60	b 8.09	.....	c 1.11	1.54	1.87	d 1.19	.....	e .42

a Average of 8 analyses.

b Average of 30 analyses.

c Average of 24 analyses.

d Average of 18 analyses.

e Average of 28 analyses.

TABLE 136.—Nitrogen records of the clear, filtered broth (expressed in percentage of total nitrogen in broth).

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Total nitrogen in cooked meat.	Total nitrogen in broth.	Nitrogen coagulated by heat.	Nitrogen precipitated by ZnSO <sub>4</sub> (albumenose).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromine (nitrate from ZnSO <sub>4</sub> ).
				At beginning.	During cooking.							
1642	1640	109	Beef, round.....	Cold.	85	3	5.770	100	0.23	7.63	7.86	.....
1754	1753	137	.....do.....	Cold.	85	3	5.884	100	0	9.12	9.12	.....
			Average.....	Cold.	85	3	5.827	100	.12	8.38	8.49	.....
1756	1753	139	Beef, round (browned).	Cold.	85	3	5.495	100	0	8.91	8.91	.....
			Average Nos. 1642, 1754, and 1756.....	Cold.	85	3	5.716	100	.08	8.55	8.63	.....
1746	1741	136	Beef, round (browned).	85	85	3	5.696	100	.27	11.04	11.30	.....
1769	1764	145	Beef, round.....	85	85	3	5.810	100	.79	9.14	9.92	.....
1780	1775	154	.....do.....	85	85	3	6.040	100	1.49	6.40	7.89	.....
			Average Nos. 1769 and 1780.....	85	85	3	5.925	100	1.14	7.77	8.91	.....
			Average Nos. 1746, 1769, and 1780.....	85	85	3	5.849	100	.85	8.86	9.70	.....
1641	1640	108	Beef, round.....	100	85	3	5.910	100	0	9.29	9.29	.....
1744	1741	134	.....do.....	100	85	3	5.862	100	.19	13.55	13.74	.....
1768	1764	144	.....do.....	100	85	3	5.809	100	1.13	8.63	9.76	.....
1779	1775	153	.....do.....	100	85	3	6.013	100	2.10	7.81	9.91	.....
			Average.....	100	85	3	5.774	100	.86	9.82	10.68	.....
1755	1753	138	Beef, round.....	Cold.	100	3	5.857	100	0	12.70	12.70	.....
1757	1753	140	Beef, round (browned).	Cold.	100	3	5.855	100	0	12.08	12.08	.....
			Average.....	Cold.	100	3	5.856	100	0	12.39	12.39	.....
1743	1741	133	Beef, round.....	100	100	3	5.834	100	.35	16.10	16.45	.....
1745	1741	135	Beef, round (browned).	100	100	3	5.556	100	.19	16.57	16.76	.....
			Average.....	100	100	3	5.695	100	.27	16.34	16.61	.....
			Average of all cooked 3 hours.....	.....	.....	3	5.778	100	.48	10.64	11.12	.....
1646	1647	113	Beef, round.....	Cold.	85	5	5.240	100	3.50	6.79	10.29	0.91
1645	1647	112	.....do.....	Cold.	85	5	5.420	100	.32	5.81	6.13	.73
1654	1656	116	Veal, leg.....	Cold.	85	5	5.070	100	.39	16.21	16.80	4.30
1658	1662	118	.....do.....	Cold.	85	5	4.800	100	.52	21.01	21.53	.71
			Average Nos. 1654 and 1658.....	Cold.	85	5	4.935	100	.56	18.61	19.17	2.51
			Average Nos. 1645, 1654, and 1658.....	Cold.	85	5	5.097	100	.48	14.34	14.82	1.91
1644	1647	111	Beef, round.....	100	85	5	5.590	100	.46	9.70	10.16	.54
1720	1722	131	.....do.....	100	85	5	5.309	100	0	13.14	13.14	.....
			Average.....	100	85	5	5.450	100	.23	11.42	11.65	.....
1665	1668	121	Beef, neck.....	100	85	5	5.039	100	1.07	.....	.....	1.25
1673	1676	123	Beef, rump.....	100	85	5	3.245	100	.33	19.98	20.30	.69
1703	1705	125	.....do.....	100	85	5	4.433	100	1.21	15.15	16.36	.....
			Average Nos. 1673 and 1703.....	100	85	5	3.839	100	.77	17.57	18.33	.....



TABLE 136.—*Nitrogen records of the clear, filtered broth (expressed in percentage of total nitrogen in broth)*—Continued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Temperature.		Duration of cooking.	Total nitrogen in cooked meat.	Total nitrogen in broth.	Nitrogen coagulated by heat.	Nitrogen precipitated by ZnSO <sub>4</sub> (albumose).	Sum of coagulable and albumose nitrogen.	Nitrogen precipitated by bromin in filtrate from ZnSO <sub>4</sub> .
				At beginning.	During cooking.							
				°C.	°C.	Hrs.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
1669	1672	122	Beef, flank.....	100	85	5	3.210	100	0.68	33.92	34.60	0.65
1653	1656	113	Veal, leg.....	100	85	5	5.360	100	1.40	7.30	8.69	4.92
1664	1662	117	.....do.....	100	85	5	4.900	100	.52	22.90	23.42	.88
			Average Nos. 1633 and 1664...	100	85	5	5.130	100	.96	15.10	16.06	2.90
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720...	100	85	5	4.636	100	.71	17.44	18.10	1.49
1639	1637	107	Beef, round.....	100	100	5	5.640	100	.50	15.63	16.13	.....
1643	1647	110	.....do.....	100	100	5	5.370	100	1.01	17.06	18.07	.87
1721	1722	132	.....do.....	100	100	5	5.324	100	0	25.42	25.42	.....
			Average.....	100	100	5	5.445	100	.50	19.37	19.87	.....
1704	1705	126	Beef, rump.....	100	100	5	4.583	100	.92	36.02	36.94	.....
1652	1656	114	Veal, leg.....	100	100	5	5.310	100	.56	23.43	23.99	4.91
			Average Nos. 1630, 1643, 1652, 1704, and 1721...	100	100	5	5.245	100	.60	23.51	24.11	.....
			Average of all cooked 5 hours.....	.....	.....	5	4.932	100	.80	18.09	18.88	a 1.78
			Average of all cooked 3 or 5 hours.....	.....	.....	.....	5.314	100	.66	b 5.81	b 15.26	.....
Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Proteid nitrogen in broth.								Nitrogen as free ammonia.
				Proteid nitrogen in broth.	Nonproteid nitrogen in broth.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen precipitated by alcohol.	
				P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
1642	1640	109	Beef, round.....	7.86	92.14	.....	9.87	7.66	32.23	.....	.....	.....
1754	1753	137	.....do.....	9.12	90.88	.....	9.35	12.18	16.82	.....	.....	4.51
			Average.....	8.49	91.51	.....	9.57	8.51	22.21	16.82	.....	4.51
1756	1753	139	Beef, round (browned).	8.91	91.09	.....	9.30	9.07	11.49	15.62	.....	4.41
			Average Nos. 1642, 1754, and 1756.....	8.63	91.37	.....	9.59	8.60	18.63	16.23	.....	4.46
1746	1741	136	Beef, round (browned).	11.30	88.70	.....	9.35	10.54	11.23	5.54	.....	3.88
1769	1764	145	Beef, round.....	9.92	90.08	.....	8.05	10.52	11.12	13.37	.....	4.31
1780	1775	154	.....do.....	7.89	92.11	.....	8.87	4.98	7.89	14.21	.....	4.95
			Average Nos. 1769 and 1780...	8.91	91.09	.....	8.46	7.75	9.51	13.79	.....	4.63
			Average Nos. 1746, 1769, and 1780.....	9.70	90.30	.....	8.76	8.68	10.08	11.04	.....	4.38
1641	1640	108	Beef, round.....	9.29	90.71	.....	.....	10.38	33.29	.....	.....	.....
1744	1741	134	.....do.....	13.74	86.26	.....	10.83	12.10	17.15	.....	.....	4.00
1768	1764	144	.....do.....	9.76	90.24	.....	7.92	8.38	11.39	13.82	.....	3.94
1779	1775	153	.....do.....	9.91	90.09	.....	8.96	4.21	7.73	12.94	.....	3.71
			Average.....	10.68	89.32	.....	9.24	8.77	17.39	10.79	.....	3.88

a. Average of 12 analyses.

b. Average of 30 analyses.



TABLE 136.—*Nitrogen records of the clear, filtered broth (expressed in percentage of total nitrogen in broth)*—Continued.

Laboratory No.	Raw meat used No.	Cooking experiment No.	Kind of meat.	Protein nitrogen in broth.	Nonprotein nitrogen in broth.	Nitrogen precipitated by bromin directly.	Nitrogen precipitated by phosphotungstic acid (hot).	Nitrogen precipitated by tannin and salt.	Nitrogen precipitated by phosphotungstic acid (cold).	Nitrogen precipitated by Stutzer's reagent.	Nitrogen precipitated by alcohol.	Nitrogen as free ammonia.
1755	1753	138	Beef, round.....	P. ct. 12.70	P. ct. 87.30	P. ct. ....	P. ct. 13.01	P. ct. 12.89	P. ct. 13.04	P. ct. 16.28	P. ct. ....	P. ct. 5.54
1757	1753	140	Beef, round (browned).....	12.08	87.92	.....	11.19	9.68	12.59	14.82	.....	5.41
			Average.....	12.39	87.61	.....	12.10	11.29	12.72	15.55	.....	5.48
1743	1741	133	Beef, round.....	16.45	83.55	.....	8.11	25.83	7.81	6.99	.....	4.58
1745	1741	135	Beef, round (browned).....	16.76	83.24	.....	9.79	17.11	17.27	8.81	.....	5.04
			Average.....	16.61	83.39	.....	8.95	21.47	12.54	7.90	.....	4.81
			Average of all cooked 3 hours.....	11.12	88.88	.....	9.61	10.91	14.73	12.07	.....	4.52
1646	1647	113	Beef, round.....	11.20	88.80	.....	.....	11.62	13.19	.....	.....	.72
1645	1647	112	.....do.....	6.86	93.14	.....	.....	10.56	11.29	.....	.....	1.26
1654	1656	116	Veal, leg.....	21.10	78.90	10.16	6.38	11.91	11.49	.....	.....	3.94
1658	1662	118	.....do.....	22.24	77.76	20.68	7.55	25.21	20.49	.....	.....	4.36
			Average Nos. 1654 and 1658.....	21.67	78.33	15.42	6.97	18.56	15.99	.....	.....	4.15
			Average Nbs. 1645, 1654, and 1658.....	16.73	83.27	.....	.....	15.89	14.42	.....	.....	3.19
1644	1647	111	Beef, round.....	10.70	89.30	.....	.....	10.79	18.61	.....	.....	1.85
1720	1722	131	.....do.....	13.14	86.86	.....	13.80	13.63	15.43	12.40	32.83	3.74
			Average.....	11.92	88.08	.....	.....	12.21	17.02	.....	.....	2.60
1665	1668	121	Beef, neck.....	.....	.....	11.08	8.31	13.45	17.65	.....	.....	8.27
1673	1676	123	Beef, rump.....	20.99	79.01	28.78	16.71	11.86	13.78	.....	.....	5.50
1703	1705	125	.....do.....	16.36	83.64	.....	17.36	15.69	17.81	9.89	28.00	5.96
			Average Nos. 1673 and 1703.....	18.68	81.33	.....	17.04	13.78	15.30	.....	.....	5.73
1669	1672	122	Beef, flank.....	35.25	64.75	28.92	15.70	36.69	32.84	.....	.....	7.02
1653	1656	113	Veal, leg.....	13.61	86.39	5.77	4.03	6.44	14.40	.....	.....	4.54
1664	1662	117	.....do.....	24.30	75.70	20.08	7.47	25.15	21.75	.....	.....	4.24
			Average Nos. 1653 and 1664.....	18.96	81.04	12.93	5.75	15.80	18.08	.....	.....	4.39
			Average Nos. 1644, 1653, 1664, 1665, 1669, 1673, 1703, and 1720.....	19.20	80.81	18.93	11.91	16.72	18.91	.....	.....	5.09
1639	1637	107	Beef, round.....	16.13	83.87	.....	.....	23.56	52.03	.....	.....	.....
1643	1647	110	.....do.....	18.94	81.06	.....	.....	20.97	27.47	.....	.....	2.11
1721	1722	132	.....do.....	25.42	74.58	.....	19.79	24.42	24.52	11.65	42.91	4.68
			Average.....	20.16	79.84	.....	.....	22.98	34.67	.....	.....	3.40
1704	1705	126	Beef, rump.....	36.94	63.06	.....	23.11	36.20	32.16	17.77	47.85	5.15
1652	1656	114	Veal, leg.....	28.91	71.09	17.03	12.98	23.30	25.39	.....	.....	4.75
			Average Nos. 1639, 1643, 1652, 1704, and 1721.....	25.27	74.73	.....	18.63	25.69	32.31	.....	.....	4.12
			Average of all cooked 5 hours.....	20.13	79.87	17.82	12.77	18.91	21.72	12.93	437.90	4.22
			Average of all cooked 3 or 5 hours.....	15.93	84.07	.....	11.19	15.30	18.56	12.29	.....	4.35

a Average of 8 analyses.

b Average of 4 analyses.

c Average of 30 analyses.

d Average of 24 analyses.

e Average of 16 analyses.

f Average of 28 analyses.

From Table 134 it will be seen that the clear, filtered broths contain from 0.2238 to 0.3787 per cent total nitrogen, the average being 0.3144 per cent. These figures compared with those in Table 108 show that the amount of total nitrogen in clear meat broths is much less than that contained in the cold-water extracts of uncooked meats, when the results are expressed upon the same basis.

The nitrogen found in the clear, filtered broths in the form of proteids coagulable by heat in neutral solution varies from none in a number of cases to 0.0116 per cent, the average being 0.0020 per cent; the albumose nitrogen precipitated with zinc sulphate ranged from 0.0163 to 0.1364 per cent, averaging 0.0470 per cent of the entire weight of the fresh meats; the soluble proteid nitrogen varied from 0.0201 to 0.1399 per cent, the average being 0.0510 per cent, and the nonproteid nitrogen in the clear broths ranged from 0.1798 to 0.3409 per cent, averaging 0.2664 per cent.

A small quantity of nitrogen was present as ammonia or ammonium salts, the average amount being 0.0133 per cent.

The average quantities of nitrogen precipitated by various reagents from clear broths were: Bromin 0.0512 per cent, phosphotungstic acid in a hot solution 0.0349 per cent, phosphotungstic acid in a cold solution 0.0602 per cent, tannin and salt 0.0492 per cent, and Stutzer's reagent 0.0384 per cent.

In Table 135 the nitrogen records of the clear broths are given in the form of percentages of the total nitrogen contained in the uncooked flesh. It will be there noted that the total nitrogen found in the clear broths forms from 7.22 to 13.36 per cent of the total nitrogen contained in the uncooked meat. The average amount of soluble nitrogen in the 31 samples of clear broths was 9.61 per cent of the total nitrogen. The average quantity of soluble nitrogen in the raw meats was 22.14 per cent, and the average amount of soluble nitrogen in the 31 samples of boiled meats was 4.71 per cent of the total nitrogen.

The average values for the different nitrogenous constituents are also given.

These data presented for the clear broths calculated in percentages of the total soluble nitrogen show that in a considerable number of cases there was no nitrogen in the form of compounds coagulated by heat, while in others the quantity of nitrogen in this form reaches 0.35 per cent, the average being 0.06 per cent.

The data for the other forms of nitrogen may also be readily learned from Table 136. The general conclusion from all these considerations of the character of the nitrogenous constituents of clear, filtered broths is that, as compared with raw and boiled meats, they are present largely as extractives and to but a slight extent in proteid forms.

## CONCLUSIONS.

The principal conclusions which can be drawn from the studies of meat and meat products reported in this bulletin are the following: Meats of different kinds and cuts may be analyzed directly and with accuracy—that is, without being first previously air dried. The soluble matter in meats may be completely removed by extraction with cold water and the preparation and analysis of such cold-water extracts is of great importance in studies of the true value of flesh foods. The total proportion of raw meat which is soluble in cold water is considerable, the average results showing that the cold-water extract contains about 2.3 per cent proteid, 1 per cent nitrogenous extractives, 1.6 per cent nonnitrogenous extractives, 0.7 per cent nitrogen, and 0.8 per cent ash. None of the fat present in the meat is dissolved by cold water. The proportion of each nutrient present in the original flesh which is dissolved in cold water is, on an average, proteid 13 per cent; organic extractives, including both nitrogenous and nonnitrogenous compounds, 100 per cent; ash, 81 per cent; total nitrogen, 22 per cent. Of the nitrogen compounds soluble in cold water, 46 per cent is coagulated by heat. The nitrogen present is about equally divided between proteid and nonproteid bodies.

Meats cooked by boiling are less soluble in cold water than are raw meats, the average amount of nutrients recovered in the extract as compared with the total weight of the meats used being 0.4 per cent proteid, 0.6 per cent nitrogenous extractives, 0.8 per cent non-nitrogenous extractives, 0.3 per cent nitrogen, and 0.4 per cent ash. The average ratio of nonproteid to proteid nitrogen is as 1:0.31. Expressed as percentages of the amount of each nutrient originally present, the average values for the cold-water extract of cooked meats are 1 per cent proteid, 100 per cent extractives including both nitrogenous and nonnitrogenous compounds, 67 per cent ash, and 1 per cent nitrogen. As in the case of raw meat, no fat is dissolved by the cold water.

The different methods commonly followed in cooking meat in hot water vary somewhat as to time and temperature of cooking, but the resulting cooked meats are quite similar as regards composition and also as regards the proportion of their constituents which are soluble in cold water.

Meats cooked by dry heat, as in roasting, broiling, sautéing, and frying, are on an average 2.4 times more soluble in water than boiled meats but are only a little more than half as soluble as raw meats. The results show that on an average cold water removes the following percentage amounts from meats cooked by dry heat: Proteid 0.7, nitrogenous extractives 1.3 nonnitrogenous extractives 1.6, nitrogen 0.5, and ash 1 per cent. Considered on a water-free

basis, roast meats contain about 2.3 times as much soluble proteid and nonnitrogenous extractives and 2.5 times as much nitrogenous extractives and ash as boiled meats.

The more pronounced flavor of meats cooked by dry heat as compared with those cooked in hot water is without doubt due to the larger proportion of soluble constituents which the former contains. As regards the losses in weight when meat is cooked in hot water, the average values show that it is equal to from 10 to 50 per cent of the total weight of the fresh meat used, the average being about 34 per cent. The amount of water removed by the heat of boiling ranges from about 18 to 69 per cent, the average being 45 per cent of the amount originally present. The total protein removed in the broth varies from 3 per cent to 13 per cent, averaging 7 per cent. The proportion of fat originally present in the raw meat which is recovered in the broth varies from 0.6 to 37 per cent, and the proportion of mineral matter from 20 to 67 per cent, averaging not far from 45 per cent. The nutrients in the broth expressed as percentages of the total weight of the uncooked meat on an average equal, water 31, proteid 1, fat 1, and ash 0.5 per cent. The fatter kinds and cuts of meat lose less water, proteid, and mineral matters, but more fat than leaner kinds of meat. The proportion of nutrients extracted in the broth is directly proportional to the length of time and the temperature of the cooking period. Different cuts of some kinds of meat behave differently as regards the nature and amount of the losses they sustain when cooked in hot water. On an average, the larger the piece the smaller the percentage losses. When meat is cooked in water at 80 to 85° C., placing the meat in hot or cold water at the start has little effect on the amount of material recovered in the broth. Beef used in the preparation of beef tea or broth has lost comparatively little of its total nutritive material, though most of the constituents which give flavor have been removed. The experimental data indicate that on an average 72 per cent of the nitrogenous organic extractives originally present in beef is removed during boiling, and that the average of nonnitrogenous organic extractives removed is also 72 per cent. When meats are cooked by dry heat the losses sustained are much smaller than when cooked in hot water, being, on an average, water, 35 per cent; nitrogenous extractives, 9 per cent; nonnitrogenous extractives, 17 per cent; fat, 7 per cent, and ash, 12 per cent. On an average there was an apparent gain of 4 per cent proteid, this apparently anomalous value being probably due to unavoidable faults in the experimental methods or some similar cause.

As regards the composition of complete or unfiltered meat broths, the average results vary, the total solid matter containing from 1 to 10 per cent of the total quantity of meat used. On an average

the percentage composition of a large number of broths was, water, 97 ; total solids, 3; proteid, 0.3; nitrogenous extractives, 0.6; nonnitrogenous extractives, 0.7; total organic extractives, 1.3; fat, 1.3, and ash 0.5 per cent. On an average 0.24 per cent of the total nitrogen was present as proteids and 0.18 per cent as nonproteid bodies. The clear, filtered broths contained less of the important food elements, i. e., proteids and fat, than complete or unfiltered broths, but practically the same amounts of the different extractive bodies and ash. In other words, they have less food value but fully as much flavor as the unfiltered broths, provided the fat is removed in both cases. Meat fat possesses more or less distinctive flavor, and if present modifies the flavor of the broth. Both filtered and unfiltered broths have a low food value as compared with the meats from which they are made, or as compared with meats cooked by dry heat or in hot water. This is obvious when it is remembered that broth or soup is made up largely of water.

The small amount of nutritive material in broth or soup is chiefly in the form of organic extractives. The richness of the broth increases as the size of the pieces of meat used in making it decreases. An increase in the time of cooking also increases the amount of nutrients found in the broth. The broth is very little richer when made from bones as well as meat, the chief nutrients thus added being fat and soluble proteid.

In general the various methods of cooking materially modify the appearance, texture, and flavor of meat and hence its palatability, but have little effect on total nutritive value. Whether it be cooked in hot water, as in boiling or stewing, or by dry heat, as in roasting, broiling, sautéing, or frying, meat of all kinds has a high food value when judged by the kind and amount of nutritive ingredients which are present.



















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